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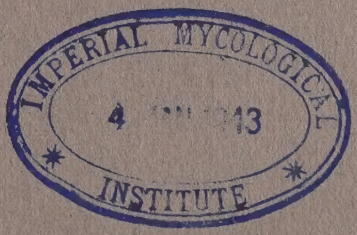

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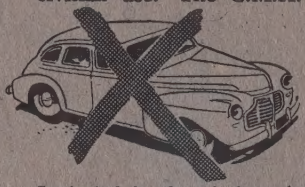

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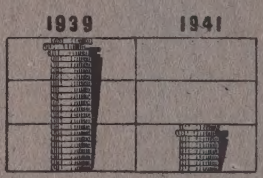

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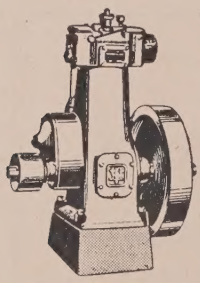

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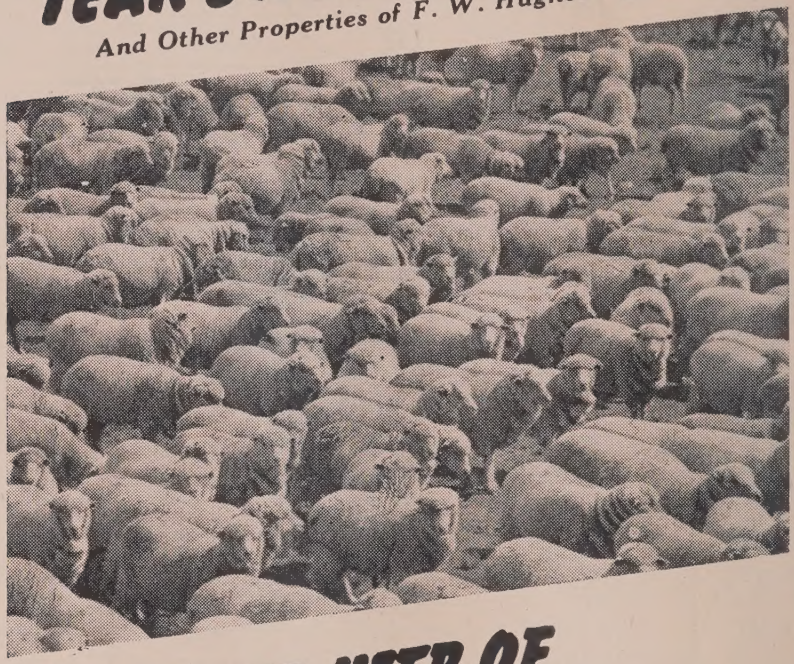

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The Fat Lamb Industry in Western Australia: Its Development and Problems

By

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The export lamb industry in Western Australia dates from about 1906, when an experimental shipment of 422 carcases was made to the United Kingdom. Records show that for the next few seasons this trade expanded rapidly, but from then on until about 1930, only intermittent shipments were made. In 1922 the West Australian Meat Export Company's Treatment Works at Robb's Jetty were established. It was felt then that there was a surplus sheep production above local consumption, part of which could be profitably exported as lamb to the United Kingdom. However, the anticipated numbers did not eventuate and up till 1930 shipments were only made in the years 1922 (25,456 carcases), 1923 (13,115) and 1928 (6,685). Since 1930, the export trade has expanded rapidly from 22,826 carcases to a peak of 363,645 in 1938. During the last three years, however, the trade has declined quite appreciably, particularly in the last year. The figures for the three years are : 1939, 315,819 carcases ; 1940, 310,544 carcases ; and 1941, approximately 250,000 carcases.

It is interesting to speculate on the reasons for this decline. Contrary to the generally accepted idea, the official Government Statistician's figures for the matings to British breed rams, and the numbers of crossbred lambs marked, have shown at least a tendency to remain stationary, if not to rise, during this period. Seasonal conditions in the ordinary accepted sense will not explain the decline, as in 1940, a poor pasture year and one during which drought conditions were experienced over much of the wheat areas, the same number was treated as in 1939, which was an excellent year. Last year, also a very good season, the numbers were roughly 80,000 lower. This raises the very interesting point as to what really constitutes a good season for fat lamb production. On the price aspect, as a factor which may influence the position, it will be remembered that, in 1939 and 1940 the price was stabilised by the Imperial Government Meat Purchase Scheme with the Commonwealth Government, at a level approximating that of the year previous to the outbreak of war. Last year, the Commonwealth Purchase Scheme operated and the prices were roughly 9 per cent. lower than those of the first two war seasons. The scheme was

so designed that the difference between the Commonwealth and the Imperial prices could form a fund from which the canning of lower grade meats, such as mutton, could be subsidised. This lower price undoubtedly was a factor contributing towards the lower numbers treated last year. It resulted in the withholding by farmers of large numbers of the lower grade lambs, which has been reflected in the numbers of last season's lambs coming forward on the metropolitan market during the summer months. There is no doubt that the demand for and consumption of lamb throughout the whole year is increasing in this State.

Some of the problems in the industry associated with breeding, husbandry and economics will now be discussed and some of the experimental work bearing on these problems, which is being carried out in cooperation with Dr. Underwood, will be described.

Breeding.

It must be realised at the outset that we are endeavouring to establish an export trade in a market which is limited, very exacting and also in competition with other States and countries, particularly New Zealand, which have been supplying that market for many years. If we are to maintain, and possibly to increase our share of that market, then it is essential that we produce the type of carcase desired. Naturally, breed plays a very important part in determining the final produce, and in consequence numerous investigations have been carried out in many places to determine the most suitable breed or combination of breeds for the particular conditions and environment.

The majority of the investigations have been confined to a consideration of the most suitable sire of the export lamb. All these experiments have clearly shown the pre-eminence of the Southdown. Much better results have been obtained with this than with other short woolled breeds, such as the Dorset Horn, Shropshire and Suffolk. The work of Dr. Hammond and his associates has given a scientific basis for these preferences in that it has been demonstrated that the Southdown type of carcase has a better conformation, more compact leg joints, a better " eye " muscle and above all, a higher percentage of meat to bone and fat. However, there are quite a number of producers who use and favour such breeds as the Shropshire, Dorset Horn and, in South Australia, the Suffolk. Whilst admitting the qualitative superiority of the Southdown, they maintain that their monetary returns from the other breeds mentioned are as good as, if not better than, those of producers who are using the Southdown. However, it is well known that the demand for the small, high quality joint is increasing in England, whilst the market for the big, lower quality carcase is definitely limited and decreasing. The recent work of Palsson at Cambridge and Edinburgh, in association with Dr. Hammond, is a valuable contribution to the question of the most suitable sire for the export lamb. He has shown that at light weights, say under 40 lb., the Southdown gives the ideal carcase with the desired proportions of muscle, fat and bone, whilst at the heavier weight the larger breeds (in his case the Suffolk) were much more suitable, the Southdown carcase being far too fat. This fact is fundamental in selecting the breed of ram, once the type of carcase it is desired to produce is determined. It gives a definite scientific explanation of the excellent gradings and returns frequently obtained from heavy-weight lambs of such breeds as the Shropshire, Dorset Horn and Suffolk.

When considering the most suitable breed of ewe under local conditions for producing the ideal sucker lamb, two points should be borne in mind. Firstly, she must be capable of producing an abundance of milk so that the lamb is suitable for the market as a sucker, and secondly, that the sheep population of this State is predominantly Merino. There is no need to detail the many experiments carried out in New South Wales, Victoria, South Australia, Western Australia or the more recent detailed investigation by Bonsma in South Africa (where somewhat similar con-

ditions to Western Australia prevail), all of which have shown that the Merino lacks certain essential qualifications for the direct production of fat lambs. It has a poor, narrow conformation, is slow maturing, and of comparative low fertility, and above all, produces insufficient milk for the promotion of optimum growth of sucker lambs. All experiments have shown the vast superiority of the crossbred ewe, which possesses those qualities mentioned as being so lacking in the Merino. Although all are agreed on this point, there is quite a deal of controversy on what is the ideal cross-bred or half-bred ewe. Excellent results have been obtained from cross-bred ewes of the Border Leicester, English Leicester, Romney Marsh and other longwool breeds, whilst the Dorset Horn has keen advocates in South Australia. Although the Dorset Horn undoubtedly is capable of producing a high quality lamb, it is a poorer wool producer than the other breeds mentioned. The relative price position of meat and wool is capable of considerable change and should not be overlooked when selecting the type of cross-bred ewe.

Possibly, some investigations are desirable to determine the most suitable cross-bred ewe for different areas, but it is suggested that, in the case of those breeds mentioned, type within the particular breed or cross may be of greater importance than the actual breed itself. All too frequently are comparisons made and successes and failures explained on the basis of the particular breed, no thought being given to the actual type and quality of the sheep themselves. On the question of breeds it may be concluded that there is a large amount of fundamental experimental data and practical experience to indicate the type of lamb likely to be obtained from any particular cross. For Smithfield's requirements, the Southdown stands pre-eminent as the ideal sire of the lamb, whilst a cross-bred ewe of good conformation and milking qualities is essential as a suitable mother. At the same time the wool producing qualities of the ewe should not be neglected.

Husbandry.

Fertility is naturally a very important question with the producer as obviously he desires the maximum " drop " of lambs from his matings to make the fullest use of his ewes on highly developed pastures and fodder crops. It is, of course, well known that fertility is an inherited character and varies considerably with the different breeds. Most of the British breeds are highly fertile, with a distinct tendency towards twinning, whilst the Merino is of low fertility, with twinning rather rare. On the other hand, it has been known for a long time that nutrition also plays an important part in this question. There has, however, been a number of lavish claims made regarding the effect of different levels of nutrition on the fertility of the ewe. When one examines the experimental evidence one finds that conclusions have often been drawn from rather meagre data.

During the mating season of 1939 an experiment to obtain information on this point was conducted at the Avondale Research Station.[1] A flock of 700 Border Leicester × Merino ewes was divided into two similar groups. One group was first brought down in condition by restricted grazing and then " flushed " on dry oaten and pea stubble for four weeks prior to and during mating. The second group was provided with dry grazing, which at first just maintained their condition and then gradually reduced it prior to and during mating. It was found that the " flushing " treatment produced a highly significant increase in fertility brought about entirely through an increase in the proportion of twins. The lambing percentage (on the basis of lambs reared) of the flushed group was 109·4, including 18 per cent. of twins, whilst the corresponding figures for the " unflushed " group were 91·1 per cent. and 2 per cent. of twins. The flushing, however, did not bring the ewes into œstrus any earlier, had no effect in restricting the period of lambing, and did not induce a greater percentage of twins during the first part of the lambing season.

An interesting finding in this experiment was that the lambing occurred in definite modes or waves with peaks of intensity approximating to the normal diœstrus period of 17 days. Examination of lambing details from previous experiments disclosed a similar position. It may be that this is the natural distribution one would anticipate in ewes coming in season after a period of anœstrum. From a practical point of view, however, if a restricted or intensified lambing is desired it would indicate the need of a high percentage of rams to mate with the ewes if they are mostly in season over a few days rather than evenly distributed through the normal 17-day period.

Another aspect of fertility which has been investigated is the possible value of gonadotrophic or sex gland stimulating hormones for bringing ewes in season in the non-breeding or anœstrum period. Much work has been done in England, America and Russia with these extracts on all classes of livestock, both male and female. Whilst the results of different workers have been highly variable, there is quite a deal of evidence to show that certain of these preparations under appropriate conditions can be used with success to induce heat or œstrum and ovulation in the ewe. In this State, the British breeds with the exception of the Dorset Horn, come in season not before late February, and more usually in March-April, resulting in an August and September lambing. In consequence, these lambs have a short green feed period in their first year of life and are weaned in the summer when the natural grazing is poor. Unless heavy and costly supplementary feeding is resorted to, their growth and development will be retarded. Any means of bringing such ewes in season two to three months earlier would be of distinct value to the breeders of British breed rams in this State and the fat lamb industry in general. Experiments to test the value of one of these gonadotrophic preparations, " Gonadin ", were carried out in 1939-40 and 1940-41 on four private flocks and also at the Avondale Research Station.[3] The results were disappointing. They were, however, sufficient to indicate that the material had some possibilities, but considerable work of a fundamental nature was apparently required to standardise the preparation and dosage for the British breeds of sheep.

Pre-Natal Feeding.

It is well recognised that good nutritional conditions for the ewe and her lamb, particularly during its first three months of life, are of paramount importance for producing a prime sucker lamb. It is not so well known, however, that the feeding treatment prior to lambing, particularly during the last third of pregnancy, can exert a profound influence on the subsequent lamb. Increased birth weight and accelerated growth as a consequence of the greater udder development in the ewe, resulting from improved nutrition during late pregnancy, have been claimed by a number of overseas workers. To obtain definite experimental evidence on this point, and if possible suggest suitable and economic rations under local conditions, a series of experiments have been inaugurated at Avondale. Last year, the value of a small " practical " ration of ½ lb. wheat per head per day for the last six weeks of pregnancy was tested as a supplement to the dry natural grazing.[2] It was found that this small amount of extra feed did not result in an increase in the birth weight or an improved rate of growth in the lambs as compared with those from the unsupplemented ewes in the control groups. It did, however, have a very marked effect in reducing losses of both ewes and lambs at lambing time. The cost of the ration worked out at roughly £5 per hundred ewes, whilst the reduced losses in the fed group as compared with unfed controls was equivalent to three times this amount.

Two points of interest arising out of last year's experiment were firstly, the shorter time required by the heavier birth-weight lambs to reach the same pre-slaughter live weight (equivalent to approximately one week for every increase of 1 lb. in

birth weight), and secondly, the lower general average of the birth weight and the much slower rate of growth of these 1941 lambs compared with those in previous years. A consideration of these results as a whole indicated that the ewes were genetically capable of producing much heavier lambs and a much higher growth rate than in 1941, and suggested, further, that a good lamb season may be as much determined by conditions prior to birth—either early rains or particularly good grazing, or hand feeding—as by conditions subsequent to birth, which are ordinarily regarded as determining the quality of the season.

For this year it was originally planned to use a much higher level of supplementary feeding during late pregnancy, but the unusually early rains and resulting green feed necessitated some modification of the original plans. The principal object of the experiment was followed, but the " steaming up " was done with early green barley crops. The control group was pastured on rather sparse *Erodium* and small barley grass. The results of this trial are, of course, as yet incomplete, but the details so far are quite interesting. The differential treatments commenced six weeks prior to lambing when both groups were the same weight, namely 120 lb. In the six weeks the controls just maintained their initial weight, whilst the group on the barley gained roughly 34 lb. As in the previous year, the improved conditions had a marked effect in preventing losses. However, in marked contrast to the previous experiment, there was an appreciable difference in birth weight in favour of both single and twin lambs from the " steamed up " groups. The difference was most marked in the case of the twins. The effect of this increased birth weight on subsequent growth rate and carcase quality is at present being investigated. The losses of ewes in both years in the control group were practically all due to the disease pregnancy toxæmia, whilst no cases of the disease occurred in the " fed " groups. This disease causes losses of varying degree, up to serious proportions every year. The finding that improved nutritional conditions for the six weeks prior to lambing prevents these losses is of distinct practical value. A point of more than passing interest was that small amounts of green feed did not prevent the occurrence of the disease, as in 1941 it formed portion, and in 1942 all, of the grazing of the control sheep.

Economic Considerations.

An aspect of the Commonwealth control of the meat industry, other than the actual price reduction, which will tend to lower production, is the absence of any clear-cut and definite proposals with regard to price, types and weight grades on a reasonably long-term basis. The many vague warnings of lowered prices, shipping and storage difficulties and the possible rejection of certain weight and quality grades during the last year will very probably be felt in the lamb industry during the coming season.

The present need for large quantities of meat emphasises the desirability of a long-term stabilised price proposal for the meat industry in general. Such a proposal is essential to create a feeling of security and confidence amongst farmers and encourage the development of fat lamb in competition with old established industries such as wool and wheat. The stabilised wheat price, which has necessitated restrictions in acreage to prevent over-production, makes an interesting comparison, as also does the wool industry with its guaranteed price for the duration of the war and one year thereafter plus a 15 per cent. increase announced recently to cover increased costs.

There seems no question whatever that, under present conditions, there must be greater Commonwealth control of agricultural production. It is suggested that this control, however inevitable and essential for present requirements, should be exercised and planned on a reasonably long term basis. It must be designed not only for the present situation, but also must appreciate the likely post-war demand and markets.

It would be unwise from a number of viewpoints to encourage development of an industry on account of present demands, without making some provision to handle the surplus, should the local demand suddenly cease. These considerations appear to be envisaged in the recent reported proposals of the Agricultural Council with regard to pig production. There has been, however, no government pronouncement as to whether or not increased production of lambs is desired, but it would appear that increased local demands would be able to absorb at least a large proportion of the quantities, which have been exported to Great Britain in the last three years but which it may now not be possible, owing to shipping difficulties, to export.

Western Australia's peak export of 360,000 fat lamb carcases in 1938 obviously does not represent the full possibilities of the industry, when it is remembered that there are 3,000,000 breeding ewes in the agricultural areas, and of these 2,000,000 are in the areas experiencing a rainfall of 15 inches and over. Even if no increases are desired at the present time, it would be unsound to allow, what was before the war, a sound and expanding export industry to languish through any short-sighted policy. Another economic aspect deserving of some consideration—excluding present war conditions—is the desirable limit of possible production and markets for the future. Before the war it was estimated that, of the world's trade in mutton and lamb, Great Britain accounted for 93 per cent. of the imports. New Zealand supplied 53 per cent. of these imports, and Australia as a whole 28 per cent., whilst the 360,000 exported by this State in 1938 represents a mere 1½ per cent. For these and other considerations mentioned previously, a definite government pronouncement of policy with regard to the fat lamb industry on a long range viewpoint is obviously desirable to maintain confidence and stability amongst producers in what was one of Australia's soundest export industries under pre-war conditions.

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The Place of Lucerne and Annual Species of *Medicago* in Australian Cereal Areas

By

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The statement that " it is a well established fact that alfalfa requires more water per unit of dry matter produced than any other commonly grown field crop "[12] is rather provocative in this country, where the species is so often recommended as a suitable pasture plant for lower rainfall regions. Although any attempt to assess the real value of lucerne for grazing in Australian cereal areas must be handicapped greatly by the inadequacy of available data, an examination of known facts and some general discussion of the subject may well stimulate worthwhile enquiry and observation. It is most desirable that there should be in Australia a better understanding of the life history, the essential requirements and the effects of growing lucerne on any important soil type where climatic and other conditions permit its growth. Furthermore, it is important that lucerne should be placed in its true position with respect to other legumes of some value in such regions, particularly the annual species of the genus *Medicago*.

The acreage of lucerne devoted mainly to grazing in Australia is not uniformly distributed throughout cereal growing areas. Grazing lucerne is of some importance in all States except Western Australia and Tasmania. In 1938-39 the greatest concentration was in New South Wales where there were 234,854 acres, whilst South Australia with 5,486 acres had the smallest amount. Since then dry seasons and general overstocking probably have reduced the acreage considerably.

Water Requirements of Lucerne.

Several workers have investigated the water requirements of lucerne and other common crop plants. Richardson[17] in Victoria did careful pot work to find that the transpiration ratio for lucerne during a four-year period was 790 as compared with 380 for wheat and 390 for oats. An important point, however, was the considerable variation in water requirements at different times of the year ; thus it was found that for three cuttings in spring and early summer the transpiration ratio was 597, but was 1,085 for the three cuttings harvested in summer and early autumn. At a later date, further evidence was gained in Nebraska by Kiesselbach and Anderson.[11] They found that lucerne transpired 858 weight units of water for each unit of dry matter produced during the normal growth period ; inefficient use of water was indicated here, as such a transpiration ratio was in effect 3·2, 2·7 and 2·1 times that found for maize, wheat and oats, respectively. Similar evidence was obtained in Colorado by Shantz and Piemeisel[19] who reported as an average for seven years a transpiration ratio for lucerne of 859 ± 10 ; under their conditions this was 2·4, 1·8 and 1·4 times that of maize, wheat and oats.

If an average transpiration ratio for lucerne of 850 may be assumed, then 8·41 inches of water will be transpired for the production of one ton of dry mature plant material per acre. The water requirements of lucerne in the field have been investigated in connection with irrigation practices at a number of centres in America. The obtaining of accurate data is difficult owing to the necessity for considering soil-stored water, rainfall and irrigation water as sources of moisture, and because of the wastage factor ; allowance must also be made for out of season growth and main-

tenance. Carefully controlled irrigation experiments in southern Alberta[5] showed that about 6 inches of water were required to produce one ton of hay. Assuming a moisture content of 15 per cent. in the hay, it is seen that about 7 inches of water were used per ton of dry matter elaborated. In New Mexico[5] on the other hand, it has been found that 9·27 inches of water are used per ton of lucerne hay. This is in general accordance with Richardson's figures,[17] which showed that this plant makes more efficient use of moisture in cooler weather. Other investigations, particularly those undertaken in western Nebraska,[5] have demonstrated different water requirements in different seasons. This might be expected, as accurate work[18] has proved that in the case of other species there may be quite marked seasonal fluctuations in moisture requirements due to variations in the intensity of the environmental conditions. It has been pointed out by Richardson and Trumble[18] that transpiration losses depend not only on the area of green transpiring surface, but also on such variables as mean air temperature, saturation deficit of the air and wind movements. It is not characteristic of the Australian cereal areas generally for climatic conditions during the normal growing period of lucerne to favour a more efficient use of water than that indicated above. Particular allowance must also be made for run-off, evaporation from the soil surface and transpiration by weedy species under our conditions.

The Subsoil Moisture Factor.

The effect of lucerne stands on the subsoil moisture has been studied in some detail in Nebraska.[12] There it was shown that the production of hay, by a new stand on a certain area not previously cropped to this species, over a period of five years would have required the transpiration of 134·0 inches of water by the lucerne alone. During the course of the experiment only 131·3 inches of rainfall had been received, but 32·9 inches had been removed from the subsoil. It appeared that 23 per cent. of the precipitation had not been available to the lucerne. The greatest amount of hay was produced in the second year when 34·4 per cent. of the total five-year production was obtained; this yield would have required 46·2 inches of rain, but the total rainfall for that season was only 29·0 inches, and there had been a similar but smaller deficiency in the preceding year. The declining yields indicated that a large proportion of the 32·9 inches of subsoil water drawn upon had been removed in the early years of the stand, and the remainder had been exhausted mainly in the fourth and fifth years. As a result, in less than six years the lucerne had drawn on the reserves of water in the deep subsoil to such an extent that this moisture had been reduced almost to a point of non-availability to a depth of 22 feet; furthermore, an appreciable amount had been used from below that level to a depth of at least 30 feet. In succeeding years the stand would be dependent entirely on the seasonal rainfall and therefore presumably very low yielding. Further observations in Nebraska showed that a lucerne stand which had produced little in the first year but a good crop of 4·21 tons of hay per acre in the second season had depleted the subsoil moisture to a considerable degree. "A marked reduction in free-water extended to the twenty-third foot with some indication that a little water had been drawn from the twenty-fifth foot."[12]

It is reasonable to expect that much of the lucerne being grown for grazing in Australia on upland soils in regions of moderate to low rainfall similarly depends to a large extent on moisture accumulated over a long period and stored in the subsoil. Such would explain the behaviour of most of our dryland stands. There is no real proof available here, but if in Nebraska a lucerne stand which was quite high yielding in the second year, according to our standards, has become uneconomic because of water deficit by the sixth year, better performances in general cannot be expected in Australian cereal areas. Allowance must be made when considering these results for the remarkable depth of soil and the fact that the average annual rainfall of

27·51 inches obtained at Lincoln, Nebraska, is rather better than that obtained in areas considered suitable for grazing lucerne here. Although of the torrential summer type, most of the precipitation at Lincoln comes during the growing season.

The following table shows the average annual rainfall and its summer-winter distribution for some Australian wheat belt localities.[1]

Place.	Number of Years Recorded.	Average Annual Rainfall in Inches for		
		Year.	Oct.-March.	Aug.-April.
Roseworthy, S.A.	44	17·32	5·65	11·90
Condobolin, N.S.W. ..	50	16·98	8·76	12·71
Parkes, N.S.W.	41	21·10	10·48	15·42
Narrabri, N.S.W.	60	25·66	14·69	19·57

Roseworthy is representative of the better class southern mallee wheat area; there the precipitation has a marked winter incidence and lucerne grows mainly in the spring and to a lesser degree in the autumn; conserved winter rainfall and probably subsoil moisture, whilst they last, enable the plants to make some production or at least remain green throughout the dry summer. Condobolin is in the lower rainfall marginal wheat area and Parkes is the centre of a good wheat district in the intermediate or non-seasonal rainfall region. Narrabri might be considered as typical of the northern summer rainfall wheat areas. When due allowance is made for the general ineffectiveness of light falls in summer and the high evaporation from the soil surface after even relatively heavy falls, it appears that the natural precipitation, especially in the lower rainfall mallee areas, would not promote a great growth of lucerne.

If the growing of this water-wasting crop in relatively arid cereal areas is dependent upon the availability of subsoil moisture, and if under most Australian wheat belt conditions where lucerne is grown this conserved water is rapidly depleted, then the ultimate future of this crop plant in such areas may well depend on the natural rate of restoration of such reserves. Even in such higher rainfall areas as are suited to the growth of this species, it is to be expected that the roots normally penetrate deeply into the subsoil and that the water obtained therefrom contributes materially to growth. This subsoil moisture apparently is replenished by ground water movement to some extent during the summer whilst it is being used, and to a greater degree in the winter months in the case of some alluvial flats or certain soils adjacent to irrigated areas. On other country, however, such restoration of subsoil moisture would be most unusual and, except in the case of areas subject to periodic flooding, replenishment must come from any absorbed natural precipitation in excess of the needs of plants occupying the land. In moderate and low rainfall areas this is likely to be a slow process.

When lucerne was grown for six years on upland soil in Nebraska,[12] and subsequently a normal rotation of maize, oats and winter wheat was practised, a period of 225 years would have elapsed before the subsoil moisture between 5 and 35 feet was restored to the average of 10 per cent. characteristic of similar land which had not carried lucerne. It is clear that the rate of restoration of subsoil moisture will depend on the amount and nature of the annual precipitation, the absorptive capacity of the soil and subsoil, and the percentage of absorbed moisture lost by evaporation and transpiration. In most of the Australian areas under consideration the rainfall

is seldom in excess of the needs of the herbage cover. The capacity of the soil to absorb moisture will depend on the character of the cover, the topography, and the nature and mechanical condition of the soil and subsoil; likewise the amount of absorbed water lost will depend on the character of the cover, rapidity of absorption, and the power of the soil to retain moisture. Under field conditions water is most efficiently conserved by careful fallowing. At Lincoln, Nebraska,[13] where the average annual rainfall is 27·51 inches, experiments have shown that complete restoration of subsoil moisture removed by lucerne in a 5- to 6-year period requires continuous clean summer fallow for 9 to 10 years. The conclusion drawn was that "deliberate effort toward subsoil moisture restoration is likely to be a very disappointing procedure except under most advantageous circumstances". Duly[4] reported in 1929 that in Kansas very little moisture was restored to land cropped with cereals for 10 years after having grown lucerne, despite a summer maximum average annual rainfall of 31·43 inches. Considerable restoration resulted in one instance, however, from a short period of fallow during which 16 inches of rain fell. Subsequently Grandfield and Metzger[9] working at Manhattan, Kansas, where there is a similar rainfall of 31·49 inches, found that lucerne cropping had depleted a certain soil of available moisture to a depth of nearly 25 feet. When run-off from this dried-out soil was prevented and the land was clean fallowed for two years, water was stored in some amount to a depth of 25 feet; but when lucerne was resown it again removed this conserved moisture in two years. The time taken to restore the subsoil moisture to that normally found in such soil which had never grown lucerne was not determined. It would seem that either the two years of clean fallow resulted in only a partial restoration or that the water-holding capacity of the Kansas soil was rather less than that of the Nebraska soil.

In Australia there is plenty of evidence to indicate that lucerne grown in cereal areas depends in great measure upon conserved subsoil moisture and rapidly exhausts it. In discussing the suitability of the species for grazing in the central-western portion of the New South Wales wheat belt, Powell[16] stated that "the failure to persist, of good strikes obtained in the past four or five years, has caused the impression that lucerne is not suited to this district". He then pointed out that "a noticeable number of the failures have been on land just out of lucerne". Further clarification of the position and emphasis of facts seems necessary because, as Powell observed, "a very satisfactory stand gives the incentive to sow the same area to lucerne again when the old stand weakens. Lack of moisture in the lower depths of the subsoil, which caused the death of the old stand, will prevent the new sowing from becoming a good persistent paddock."[16]

With regard to restoration it can almost be said that it is a well-known fact that when lucerne is grown for several years in rotation with cereals or when a deteriorated lucerne stand is broken up, the soil will be dangerously dry. As a rule the soil is desiccated to such an extent, at least in the top six feet, that care must be taken to fallow for a longer period than usual before growing even a cereal crop unless very favourable rainfall conditions follow the removal of the legume. It is almost an axiom that wheat succeeding lucerne after a normal fallow in lower rainfall cereal areas is doomed to failure in a dry season. On many soils, particularly in drier areas, prohibitive cost of clean fallowing land for a number of seasons, and the grave danger of wind and even water erosion of such soils are likely to make the restoration of subsoil moisture quite impracticable. The storing in such land of sufficient moisture for the normal needs of cereals may be problem enough.

The undertaking in Australia of investigations aimed at obtaining accurate information about the effect of lucerne on reserves of water in the subsoil and about the possibility of replacing such moisture after it has been removed by this crop is desirable.

Persistence of Lucerne in Cereal Areas.

The classical environment for lucerne provides a deep, well-drained loamy soil, abundant sunshine and a dry atmosphere, with a constant supply of water (the equivalent of about 4-acre-feet per season when nutrients are not limiting) in the soil. These conditions frequently obtain naturally on alluvial flats in temperate, non-seasonal moderate rainfall areas, where there is free movement and subterranean replenishment of ground water in the lower soil strata. On upland soils it is difficult to get the combination of dry climate and sufficient moisture ; in regions receiving a high summer rainfall, lucerne leaf diseases become serious limiting factors in the humid atmosphere, and aggressive summer growing grasses come in and compete strongly with this legume. In those regions of Australia where the precipitation has a winter incidence and is considerable, winter growing species tend to come in and utilize most of the moisture whilst the lucerne is more or less dormant ; so that generally insufficient is stored in the soil to promote much growth of lucerne in the suitably dry summer. Fortier[5] points out that experience in the growing of lucerne " shows that it thrives best in the soil and climate of the arid and semi-arid regions, provided water is supplied by irrigation ". This authority also draws attention to the fact that in the United States* more than one-third of the acreage devoted to this crop is under irrigation in the 17 western States.

In the Australian cereal areas where lucerne is grown it is provided with abundant sunshine and a remarkably dry atmosphere throughout most of the growing season ; it is doubtful if all the soils on which it is expected to grow are deep loams, though most of them are well drained. The moisture provided by the annual precipitation together with the moisture available in the soil, is almost invariably inadequate, it seems, to maintain an economic stand for many years, and except in favoured locations, insufficient to keep the plants alive for any considerable period. Green[10] reported that " the life of lucerne is in the vicinity of six years under the climatic conditions of the central plains " of New South Wales. Speaking of the northern portion of the central western wheat belt of New South Wales, Nicholson[15] stated that this species " will provide a semi-permanent pasture ", and drew attention to the fact that there ," of recent years, due in part to unfavourable seasons, the area of productive lucerne has declined ". In South Australia Spafford[20] has recommended the sowing of 3 pounds of lucerne seed per acre with superphosphate on fallowed land on the Murray Plains. He claimed that " good stands of pasturage would be established in many seasons ", and these " would carry a lot of livestock, and should last as reasonably thick stands for three or four years ".

Although the amount of subsoil moisture initially present in any particular soil in most cases must be the main factor determining the life of a stand of lucerne on that soil, there are other important factors operating. The general climate characteristic of the area must play a major part ; this involves the average annual amount and incidence of the precipitation, the mean summer and winter temperatures and atmospheric saturation deficiencies. Then within this framework the nature of particular seasons is a consideration of consequence, especially in the non-seasonal and summer rainfall cereal areas of eastern Australia. The importance of the density of the stand is too obvious to warrant elaboration. The strain of lucerne employed might be a factor ; but there is only the one general strain of lucerne available in bulk, and this must be used for both hay production and grazing purposes. There are no worthwhile data about the efficiency with regard to water consumption of available lucernes ; little effort appears to have been made to distinguish between possible drought hardiness and capacity to tap subsoil moisture and so exhaust it more rapidly. There are in this country several diseases of lucerne which might

* Approximately 13,494,000 acres of lucerne were cut for hay in U.S.A. in 1939 (U.S.D.A. Agricultural Statistics, 1940).

hasten the deterioration of stands, especially when the plants become weakened as the subsoil moisture reserves are depleted. None, however, seem to be as serious as the bacterial wilt disease present in North America. Finally, the possible effective life of a lucerne stand may be shortened materially by bad management.

Although in most of the areas of Australia where lucerne is grown for grazing there is little danger of winter killing of the plants, the maintenance of adequate root reserves of foodstuffs is a vital necessity. Graber *et al.*[6] in Wisconsin showed that the vigour and productivity of lucerne is greatly reduced and the mortality rate of the plants is increased by frequent and early cutting. In Kansas, it was found by Grandfield[8] that the minimum carbohydrate and nitrogen content of the roots was reached about 3 weeks after cutting ; the maximum accumulation seemed to occur when the plants were in full bloom. Graber and Sprague[7] subsequently showed that various cutting treatments had marked residual effects ; they " not only affected the immediate productivity of alfalfa but also subsequent productivity and survival ". There has been much work done on time and frequency of cutting in relation to yield, root reserves and permanence of stand. It is apparent that the best time to cut lucerne for hay is when it is at the one-tenth to one-half bloom stage, and that frequent cutting of it at less mature stages is very detrimental.

In this country it seems that most attention has been paid to the management of grazing lucerne in Victoria. Bartels[2] has recommended " resting periods between grazing periods during which the lucerne is allowed to grow even to the early flowering stage—if there is sufficient moisture ". He considered it likely that " most failures with lucerne arise through bad management—abuses by over-grazing and failure to topdress ". Morgan[14] advised that " a good proportion of flowers should be showing before stock are turned in on lucerne ". He found that any grazing of this hay-type plant was undesirable, but that mismanagement was essentially bad because " in addition to shortening the life of the stand, a poor system of grazing may reduce the production of the lucerne even when it is young and should be in its most vigorous years ".

There are portions of the wheat belt where lucerne has been grown satisfactorily for hay on upland soils for about six years ; so that presumably the subsoil reserves of moisture are sufficient to support a reasonably thick stand for that period. Under apparently the same soil and climatic conditions good stands have been established on fallowed land but have been destroyed, apparently by mismanagement, in the second or third year. Field experience gained in Australia indicates that it is least harmful to graze off dry-land lucerne not more frequently than once in two months. Such treatment is hardly possible in dry marginal wheat areas because growth in the warmer months commonly tends to wilt before reaching such a stage and is frequently utilised before it is very far advanced. It must be considered the exception rather than the rule for stands of grazing lucerne in lower rainfall areas to reach the flowering stage. Therefore it often seems remarkable that they should persist for even a few years under such conditions. Grandfield[6] found that growth made immediately before the onset of winter—the aftermath produced following the cutting of the last crop of hay for the season in Kansas—had a considerable capacity to elaborate organic reserves for storage in the roots. In Australia it seems likely that the grazing of lucerne in the winter when it is making little or no growth is most undesirable, because it is then that some reserves are built up.

Exploitation of Subsoil Moisture.

When all the above things are considered, it is reasonable to expect that the employment of lucerne to make use of moisture conserved in the deep subsoil may be equivalent in low rainfall areas to the mining of an asset. The depletion of subsoil moisture is unlikely to be very harmful to succeeding cereal crops so long as pre-

cautions are taken to get water back into the top six feet or so of soil. Although it is known that *Phalaris tuberosa* goes deeper, this depth is about the limit of penetration of cereals, and Burr[3] and others have shown that little moisture is elevated by capillarity from regions beyond the root zone. It is doubtful, however, if there could be as much moisture in the top six feet of soil when the region below that depth was dry, as when this region also was moist. If it is expedient to use conserved moisture, and there is no more efficient plant than lucerne available to use it, then the practice of growing lucerne in lower rainfall areas is quite sound.

The subsoil moisture should be used intelligently, however, for it may not be replaced readily. It might be advisable for a landholder to follow a definite policy of sowing lucerne for grazing on a more or less fixed proportion of the holding every 3-6 years, so that ultimately all of the property suitable for its growth would have grown lucerne once. The longer it takes to complete this rotation, the greater the chances of its being repeated successfully. A greater degree of permanency would presumably be attained by having only thin stands, thus making available more subsoil moisture per plant. This might only result in more vigorous growth of the lucerne for approximately the same time, and would depend largely on the amount of lateral movement of moisture in the soil ; furthermore, the thinner the stand, the smaller will be the percentage of the natural precipitation available to the lucerne. To check erosion, however, it is necessary to maintain the maximum ground cover ; therefore the growing of shallow rooting pasture species with a thin stand of lucerne for grazing would be advisable.

As the amount of water available is the main limiting factor in the growing of lucerne economically in lower rainfall areas, it is necessary to ensure that this is used in terms of food production in the most efficient manner possible. A lucerne improvement programme which took into account transpiration ratios might result in the discovery or production of a variety more efficient in the use of water than the material now available. If, as has been indicated, the transpiration ratio is much lower in winter than in summer, then the development of varieties with a greater ability than those now known to make growth in the cooler months of the year would be most advantageous, especially in southern winter rainfall areas. Both of these objectives might be attained by selection and breeding within the species or by successfully crossing lucerne with other species of *Medicago* which normally make their main development in the winter half of the year.

The Value of Annual Medics.

It is difficult to compare lucerne accurately with the annual species of the genus, because a comparison must be made between mainly winter-growing shallow-rooted annual species dependent upon seasonal rainfall and a perennial deep-rooted, chiefly summer-growing species which uses conserved subsoil moisture. Critical field trials can be carried out only if due attention is paid to the different systems of management required, to the variation within species of annual medics and the relation between species and soil type. Obviously, too, reliable results cannot be obtained in a few years.

A young stand of lucerne is valued for its production of fodder in the warmer months of the year and for its capacity to make rapid recovery after a dry period. Many of the annual species, when grown in the appropriate environment in Australian cereal areas, produce high yields of green fodder in the winter half of the year and an abundance of protein-rich pods which can carry sheep over the summer and autumn and are invaluable during a drought. Richardson and Trumble[18] found that Common Burr Medic (listed as *Medicago denticulata*) had the low transpiration ratio of 326. Such species as Cut-leaf Medic (*M. laciniata*) and Woolly Burr Medic (*M. minima*), which are widely distributed in lower rainfall areas in Australia, are

considered to be even hardier than this. The determination of the transpiration ratios of the annual medics in appropriate cereal area environments would be a valuable contribution.

On the evidence available it seems that lucerne grown in cereal areas depends to some extent upon subsoil moisture and becomes uneconomic when this has been exhausted usually after a comparatively short time. It seems further that various annual medics are more efficient in the use of water than lucerne and can be grown satisfactorily on the annual precipitation in Australian cereal areas.

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Phytophthora Root Rot of Citrus

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Gummosis and Foot Rot.

Diseases of citrus trees involving the production of gum accompanied by a decay of the bark of the lower trunk and crown roots, have been known since early times, and in many countries have proved to be the most destructive of all the diseases affecting this crop. It was not until 1913, however, that Fawcett in California isolated the causal organism and proved its pathogenicity. Previous to this time the disease had been variously attributed to waterlogging, a bacterial pathogen, *Fusarium* spp., etc. The researches of Fawcett[1, 2, 3] and others have now established the causes of almost all such diseases to be fungous pathogens of the genus *Phytophthora*, chiefly *P. citrophthora*, *P. palmivora* and *P. parasitica*. These species have similar parasitic abilities and can cause leaf and fruit decay and seedling blight as well as diseases of the trunk and crown roots known as collar rot, brown rot gummosis and foot rot or mal di gomma. The type of disease depends on the climate, soil type, soil management and variety of stock.

Collar rot, as the name implies, is the decay of part of the bark of the trunk above the bud union. Such lesions, if unchecked, may, under favourable conditions of temperature and humidity, ultimately ringbark the tree. Under less favourable conditions the fungus becomes inactive and the edges of the lesion callus over. Such lesions often stop at the bud union.

In the case of foot rot the crown roots are affected. Describing this disease on sweet orange stocks in Florida, Rhoads and De Busk[9] say " a large part of the root system may be affected before there are any visible indications of the trouble above ground, other than perhaps the decline of the top of the tree ".

Lesions caused by *Phytophthora* commence as firm, brown discolorations of the bark and may pass unnoticed until splitting of dead bark and consequent exudation of gum occurs. At first only the bark is affected. The margin of infected tissue is not well defined, the dark invaded portion grading gradually into the light coloured healthy part. Gumming occurs in the cambium region in advance of the fungus mycelium, and the outer layers of the adjacent wood also become stained with gum. The fungus can only be isolated from the firm brown parts of the advancing edge of a young lesion ; it appears to die out rapidly behind the margin, and secondary moulds, of which *Fusarium* spp. are the most common, become established. When this occurs the bark soon rots away and finally the wood may also decay.

The symptoms of the disease in the above-ground parts of the tree are much the same as those due to other root disorders such as *Armillaria* root rot. The foliage becomes yellow, frequently a heavy crop is set, and this is followed by the more or less rapid death of the tree in the most severe cases.

A high level of soil moisture is necessary for the development of the disease. Fawcett[4] states that in California " orchards most heavily flooded with irrigation water, especially on heavy soils, were found to be most severely affected ".

So severe were the ravages of this disease in Mediterranean countries and in the U.S.A. that by the early part of this century it had become necessary to abandon the use of susceptible stocks such as lemon and to use the seville orange stock (*Citrus aurantium*) which was resistant. More recently there has been a swing away from seville orange, which has certain disadvantages as a stock, and in California, for example, sweet orange (*Citrus sinensis*) is now being largely used. Improved methods

of culture and irrigation have rendered the foot rot phase less prevalent and it is considered that the collar rot phase may be controlled by removal of infected bark at an early stage and disinfection of the wound.

Collar and Foot Rot in N.S.W.

Collar rots, and to a less extent foot rots, have been well known in Australia since the earliest days of citrus growing. Moore (1886) states that the disease was very destructive to the orange trees about Sydney as far back as 1867. Some of these were seedlings, but later almost all plantings came to be made on rough lemon stock (*Citrus limonia*). The cause of the disease was considered by McAlpine[7] and later by Hamblin[6] to be *Fusarium limonis*.

Collar rot is still serious and destructive in coastal districts. It usually commences above the bud union and rarely does one meet a typical case of foot rot as described in overseas literature. The rough lemon stock, which is used almost universally, is more resistant than most of the varieties commonly budded on to it, so that continued humid conditions such as might be induced by heavy dews, or showery weather are sufficient to cause infection of the trunk while the roots may remain healthy. The foot rot phase appears to have been more common on sweet orange stock, which is more susceptible than rough lemon. Most of the coastal soils where citrus is grown are sandy and well drained and water does not lie around the roots for any length of time.

Phytophthora citrophthora has been isolated from collar rot lesions in a large number of cases.

Root Rot in N.S.W.

In heavier classes of soils such as occur in the Parramatta and " Hills " districts and parts of the alluvial flats along the Hawkesbury River, a deterioration in tree vigour has occurred in recent years. The roots of such trees show small to medium sized lesions extending to the surface of the wood, and chiefly located on the lower half of the root (Figure 1). These lesions occur on roots of all sizes, but only in the most advanced stages do they extend to the crown roots. The lesions grow rapidly for a period and then may cease growth, indicating change of environmental conditions and a marginal callus is formed. This is often broken by subsequent recommencement of decay. Small roots may be formed at the margin of the lesions. The development of fibrous feeding roots by such trees is always very much less than in sandy, well-drained soils and fibrous roots are often found in a decayed condition without any compensating production of new roots (Figures 2 and 3).

A similar root condition had been known to occur for a number of years in the relatively heavy, and readily waterlogged soils of the Murrumbidgee Irrigation Area. Early attempts to isolate a pathogen yielded only non-parasitic species of *Fusarium*.

The Isolation of Phytophthora.

It has now been demonstrated by the writer that *Phytophthora citrophthora* which is responsible for the production of collar rot, is also the cause of root lesions and the premature decay of fibrous roots. Isolations of this fungus were first obtained in New South Wales from root lesions in September, 1941, from an orchard in the Murrumbidgee Irrigation Area. In this case decay was proceeding rapidly in soil kept continuously damp by spray irrigation and protected from excessive heat by permanent grass. The roots showed lesions varying in size from the small type characteristic of coastal orchards to a foot rot approaching in severity those described on sweet orange stocks in Florida.

Subsequent surveys showed that the fungus was widespread throughout the Murrumbidgee Area, and heavy soils of the coast and in some parts of the Murray River citrus growing districts.

Figure 1.
Rough Lemon roots showing old lesions (A) and fresh young lesion (B).

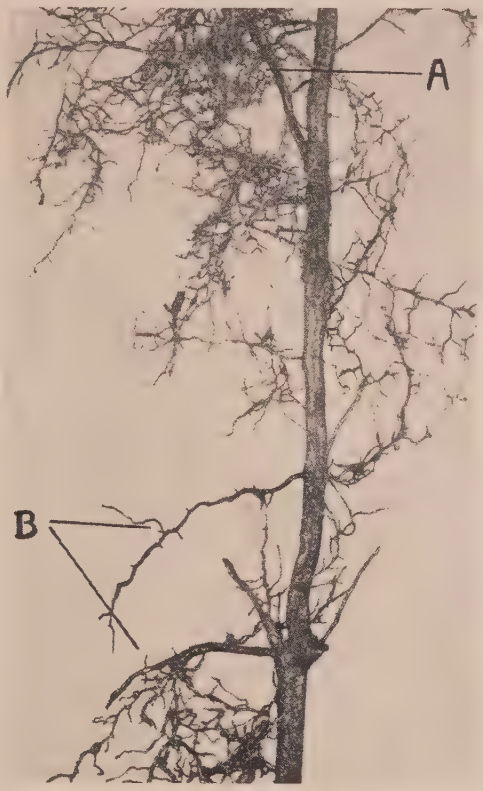

Figure 2.
Rough Lemon root showing healthy fibrous roots (A) and others partially rotted (B).

It is difficult to isolate *Phytophthora* by ordinary methods from root lesions as the invasion of the rotted area by soil saprophytes is very rapid and these outgrow and mask the pathogen in culture. It can be obtained only when the lesion is in a stage of rapid advancement. It is, however, often possible to demonstrate the presence of *Phytophthora* by floating small pieces of suspected tissue on fresh water. Typical sporangia are produced in 24 hours and the fungus can be identified with certainty.

The Importance of the Rot of Fibrous Roots.

As *Phytophthora citrophthora* is an active parasite capable of attacking all above-ground parts of a susceptible host under suitable conditions of moisture, it seemed unlikely that the damage it caused in the soil should be restricted to a rot of the larger roots, and recent work by Wager[10] in California and South Africa on Avocado root disease suggested the possibility that there might be a phase of the citrus disease which had so far been overlooked. Wager found that avocados growing in shallow soil, where a hard pan caused periodic waterlogging during wet winter months frequently showed a rapid collapse in the first warm weather after winter. It was found that the small feeding roots had decayed and *Phytophthora cinnamomi* was constantly associated with this decay. Wager was able to show experimentally that avocado plants remained unaffected in inoculated soil, so long as the soil was reasonably dry, but if it were waterlogged for a short period the feeding roots were attacked and rotted by *P. cinnamomi* so that on a return to dry conditions the plants wilted. Plants in uninoculated soil remained healthy when subjected to waterlogging conditions.

Figure 3.
Rough lemon root showing decay of small lateral root (A) and fibrous roots (B).

In order to determine whether *P. citrophthora* could cause a rot of the fibrous feeding roots of citrus, experiments with a number of different stocks were carried out at the Biological Branch Glasshouses, Sydney. It was found that under wet conditions the roots of susceptible varieties were rapidly attacked, whereas in uninoculated soil no decay occurred. Further experiments showed that saturated soil conditions were not necessary for root decay to take place, but that the rate of progress of the decay was determined by soil moisture, and was very slow in relatively dry soils. Only when the soil was waterlogged for prolonged periods did the decay extend from the fibrous roots to the main laterals. The decay of the fibrous roots took place in 24 to 48 hours after inoculation.

When it was established that *P. citrophthora* could cause the rapid decay of fibrous roots, attempts were made to demonstrate its presence in decaying fibrous roots in the field. This has been done only in a few cases, when roots were obtained showing the initial stages of decay. It has been possible, however, to isolate *P. citrophthora* from soil where recently decayed fibrous roots were present. This was done

in two ways. Seedlings of a susceptible stock were planted in the suspected soil. If the pathogen were present some of the seedlings were attacked and " damped off ", and from these *P. citrophthora* was isolated. Alternatively a sample of about ½ lb. of soil was thoroughly damped, and incubated with a mature but still green lemon. The development of a brown rot with a characteristic odour and appearance indicated the presence of the fungus.

Field observations showed that periodic rotting of fibrous roots could take place over a number of years before any sign of decay was to be observed on the larger roots, and that this phase of the disease alone could result in considerable deterioration of the health of the tree, the thinning of the canopy, failure to make adequate new growth, poor cropping and poor leaf colour.

It appears that in the majority of cases lesions on the larger roots are the result of spread of infection from fibrous roots and small laterals. The rapidity of the development of the rot of the larger roots and the amount of fibrous root lost depends on soil moisture conditions.

Varietal Susceptibility.

It has been shown by inoculations in the field and laboratory that of the four citrus varieties used for stock purposes in this country sweet orange appears to be the most susceptible, rough lemon next in susceptibility, seville orange rather resistant and trifoliata (*Poncirus trifoliata*) immune.

Sweet orange is not extensively used in New South Wales and very little is known about its field behaviour. In other countries this variety commonly shows severe foot rot symptoms under wet conditions.

Rough lemon stocks have been used for the majority of citrus plantings in N.S.W. In soils subject to waterlogging and of high water holding capacity, periodic loss of fibrous roots is to be expected, but rot of the larger roots only occurs under conditions especially favourable for the fungus and the severe foot-rot stage of the disease is uncommon. In sandy, well-drained soils where water does not lie around the roots, root decay does not occur.

Seville stock is not subject to foot rot, or to decay of the larger roots, but there is evidence that the small fibrous roots may be destroyed under particularly wet conditions. Trifoliata appears to be immune under all conditions.

The bearing of the root rot phase of the disease on current irrigation practices in the Murrumbidgee Irrigation Area, the importance of periodic winter rains and the need for stock selection and improvement are discussed by the writer[5] elsewhere.

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Agricultural Education in England

REVIEW OF A MEMORANDUM OF THE AGRICULTURAL EDUCATION ASSOCIATION.

By

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Agricultural education and extension services in England differ somewhat from their counterparts in Australia, principally in the fact that the controlling authorities are the local government bodies—the county councils. The organisation varies slightly in different parts. Over most of the country the local agricultural instructors are officers of the county council and are concerned largely with giving advice to farmers. They usually possess a degree or diploma in agriculture and sometimes in dairying, horticulture, or poultry keeping also. Some of the larger counties run their own Farm Institute, in other cases several counties combine to run one. These Farm Institutes give short courses in different aspects of practical agriculture, usually only of short duration, although in some cases courses extending over three years in preparation for the National Diploma in Agriculture are given. The teaching staff of the institute will be some or all of the agricultural instructors of the county.

In some districts there are also agricultural colleges which prepare students for both the National Diploma and for the degrees in agriculture of London University. In some cases the college may also be the agricultural department of a university, for example the South-Eastern Agricultural College at Wye, in Kent, which is the Department of Agriculture of London University.

For agricultural advisory purposes the country is divided into eleven advisory provinces : South Eastern, North-western, West Midland, and so on. For each of these provinces there is an advisory chemist, mycologist, entomologist, bacteriologist, economist and veterinary officer, each with his appropriate assistants. These officers have their offices and laboratories in university departments or in the agricultural college of the area, and usually play some part in the teaching work of the institution.

It is hoped that this brief sketch will clear up any obscurities in the following review of a memorandum of the Agricultural Education Association, some parts of which seem peculiarly apposite to the discussions which have recently taken place at joint meetings of the New South Wales branches of the Institute and the Australian Veterinary Association.

Agricultural Education and Urban Citizens.

Many urban authorities show little interest in agricultural education. There are a number of potential agriculturalists among urban children, but the boy or girl who shows a desire to take up agriculture is frequently not only unable to get the kind of encouragement and assistance that would be obtained in a rural area, but is met with discouragement. Another and not less important problem of agricultural education in relation to urban dwellers is that of developing a properly trained understanding of the agricultural industry among those whose careers do not lie in the sphere of agriculture but whose views do make up the larger part of the public opinion of the country. There is an urgent need for the recognition of two points in the general education of the non-agricultural people of the nation. Firstly, the teaching of " rural science " in schools ought not to be regarded as a specific need of rural schools alone ; an understanding of principles and processes upon which crop

and animal husbandry depend and which therefore concern the physical basis of human existence should be part of the educational birthright of everyone, townsman as well as countryman. Secondly, in advanced studies, and particularly in university courses, there should be some provision made for the study of agriculture as a constituent part of a non-agricultural course. It should be possible for a student reading either Arts or Science in a university to include an appropriate study of the history and economics of agriculture and of the position of the agricultural industry in the conspectus of commercial and social life. Facilities of this kind do exist in some universities and it is greatly to be regretted that these facilities are seldom used.

Teaching in Schools.

The teaching of agricultural subjects may be taken as the beginning of an agricultural education. There are two dangers which should be recognised :

(*a*) There is the possibility that some school-teachers may try to develop the teaching of rural science into the teaching of agriculture itself. This may be desirable for senior pupils in some rural schools, but it should only be given by an agriculturalist specially brought in for the purpose. (Literally no school-teachers are appointed with degrees in agriculture in England and Wales.)

(*b*) There is the possibility that the teaching of rural science in secondary and public schools may be developed to the partial exclusion of normal courses of study in the fundamental sciences. This must be strongly deprecated in the case of students preparing for university courses in agriculture. For such students the fundamental sciences are a part of the basic syllabus of training, and in consequence the committee considers that agricultural science is not a suitable matriculation subject. Indeed rural science becomes almost unimportant in the curriculum of those who are definitely proceeding to university agricultural studies where they will deal with rural science much more fully than is done at school. For those not proceeding to further studies agricultural science is a very suitable School Leaving Certificate subject.

A few of the public schools and secondary schools have farms that are used for agricultural instruction and manual training, and also as an instrument of general education. The latter, in the opinion of the Association, is the more valuable use. They also suggest that the training of teachers to give instruction in rural science must be given much more attention in universities and training colleges, and that appropriate courses should be arranged for those already in office.

Post-school Farm Training and Continuation Classes.

Experience of Principals of Farm Institutes suggest that it is undesirable for students to enter a farm institute until they have reached the age of eighteen years. It is suggested that the years immediately following the completion of the school education should be spent in gaining some farm experience and attending continuation classes. There are difficulties in the way of gaining successful farm experience. Even when a pupil is placed on a well-managed farm, he may not always be with a farmer who has either the time or the aptitude to instruct him. The Association recommends that the post-school continuation classes should be held on one or preferably two days a week in the day time. These are considered to be necessary on purely educational grounds. Secondly, in order that post-school farm training may be associated with technical studies and with practical studies in handicrafts and manual processes, and, thirdly, to bridge the gap between school and further training at farm institute or college. These classes have been held in the past on a voluntary basis, but not with unqualified success. If attendance at continuation classes after leaving school were obligatory, a widespread opportunity would be afforded to raise the standards of education and efficiency through a large section

of the agricultural community. The need for compulsion may not always be due to the fact that the pupil is unwilling to attend the class but that the farmer may be unwilling to release him. The Association considers, however, that such voluntary organisations as young farmers' clubs will continue to be a very desirable accompaniment of the statutory classes ; provision for a students' organisation in which they control their own business with only oversight from adult advisers should always be maintained.

Scope of the Courses in the Different Institutions.

In the Farm Institutes a general self-contained course of one session is agreed to be the basic teaching activity, although it is thought desirable that special courses in animal husbandry, crop husbandry, farm machinery, etc., should also be available for pupils wishing to make a fuller study of some branch. Whilst agriculture must be the basic teaching, the opportunity for cultural studies presented by one year's residence at a Farm Institute should not be neglected. Some arrangement for refresher courses is also considered very desirable.

The future service of Agricultural Colleges, as distinct from Farm Institutes and University Departments of Agriculture, might be enhanced if fuller recognition were given to their individual enterprise and character. At present the work tends to be too diverse. For example, one could specialise in dairying courses, another in agricultural and farm machinery, others in farm management and estate management. In this last matter, the Association has never considered the training of land and estate agents in its entirety, but it does feel competent to point out that a frequent serious defect of the training of future land and estate agents is the absence of any adequate agricultural instruction. (The same might also be said for the training of bank managers for rural areas.)

Agricultural engineering has received special consideration. As well as the training in farm machinery referred to above, there is also a need for a limited number of agricultural engineers, with a full theoretical as well as a practical training, who can become the lecturers and research workers in this subject. Appropriate courses for the training of such agricultural engineers might be instituted in a university with both an agricultural and an engineering department, or it might be better to have an independent institution as a School of Agricultural Engineering. It seems clear that, whether in a university or elsewhere, the teaching centre for agricultural engineering would need a large capital outlay for its establishment and considerable financial support for its maintenance.

On the relation of educational work, including extension work, to executive work, the members of the Association put forward two views, some members holding that these services should be combined under the one committee, whilst others feel that the confidence of the farmer in an educational officer is undermined if that officer has executive authority, and they hold that if compulsion is to be applied to agricultural education, it should be applied directly and not indirectly. In conclusion, the memorandum suggests that the closer association between research institutes and those directly concerned with advising farmers is very necessary, particularly at the present time.

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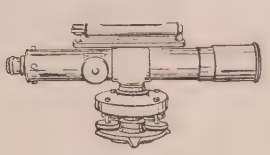

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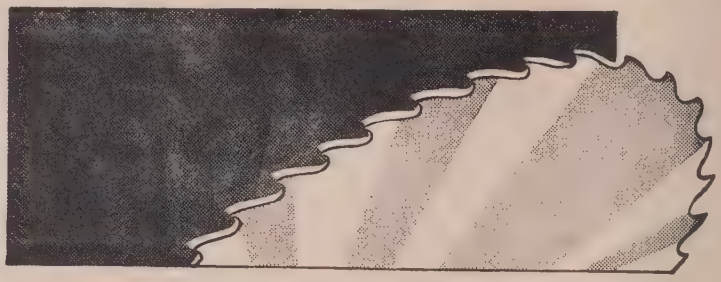

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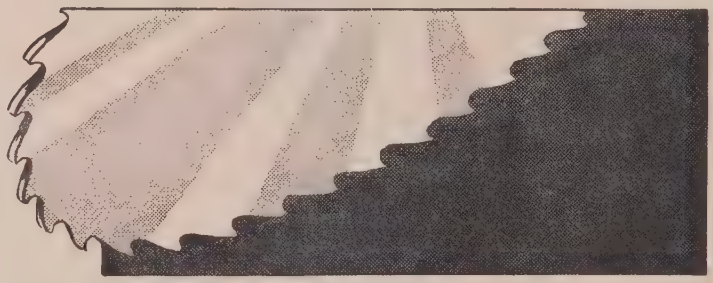

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TECHNICAL NOTES

DETERMINATION OF THE PERMANENT WILTING PERCENTAGE OF SOILS.

The permanent wilting percentage and the field capacity define the lower and upper limits of "available" water in a soil. These two quantities are important characteristics of the rooting zone of every soil, and are now being presented, along with other analytical and descriptive data, for representative soil types in soil surveys undertaken by the Council for Scientific and Industrial Research. The method used for the determination of the permanent wilting percentage is described below. Data are given indicating the degree of accuracy to be expected from the method, and the uniformity of water distribution in the soil sample at the conclusion of the test.

A dwarf variety of sunflower has been used as the test plant for these determinations. This plant gives an excellent indication of the onset of wilting (Fig. 1)

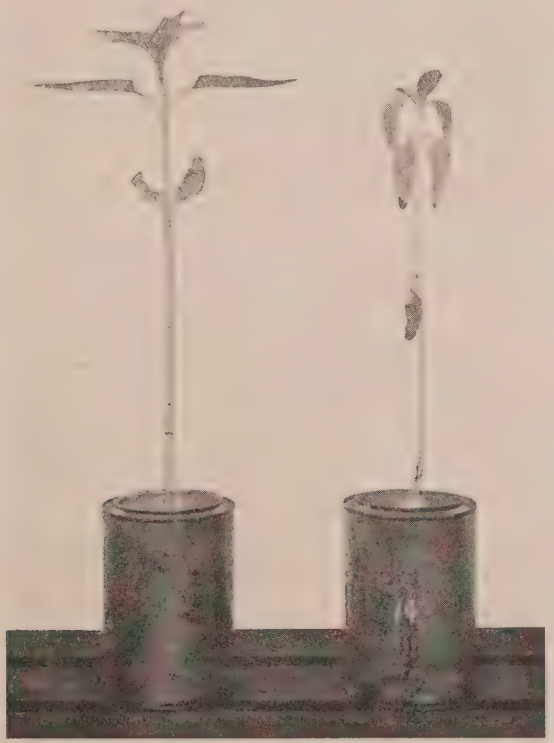

Figure 1.
Turgid (left) and wilted (right) sunflower plants near the end of a test. The plants are about 10 inches high.

and results obtained for it are comparable, according to Veihmeyer and Hendrickson,[6] with those for agricultural plants which show wilting less clearly. The effect of environment upon the results is discussed by these authors and they give a detailed review of earlier work. The method employed by us follows closely that which Veihmeyer now uses, and seeds of the test plants were obtained from the same source. Samples of soil (about 600 gm.) were placed in small honey tins, the soil was brought to field capacity and the seeds were planted. The most promising seedling was pushed through a hole in the lid of each tin. The space between the plant stem and the edge of the hole was plugged with cotton-wool, and the tins were protected from the sun by damp sawdust. At intervals during the growth of the plant the soil was brought up to its original water content but, after four pairs of leaves had grown, no further water was added. When wilting occurred the tin was placed in a humid atmosphere (in a closed bin containing a few inches of water) and left overnight ; if the leaves then became turgid, the plant was again placed in the sun until further wilting was noted. This procedure was repeated until complete recovery no longer took place. The tops were then removed and the water content of the soil determined. Approximate corrections are made by Veihmeyer for the weight of plant roots (assumed to be one-half the weight of the tops) and for the water content of the roots (assumed to be 80 per cent.). These small corrections have been applied to the results given in Table 2.

Mean values for the water contents of the upper, middle and lower sections in each of two soils are given in Table 1. The standard errors for the individual means indicate that the data are homogeneous ; it was thus possible to pool them for an analysis of variance. The analysis showed that interaction and the effect of level of sampling were insignificant. It is therefore apparent that, apart from variation over distances smaller than those under consideration, there was a uniform distribution of water in the soil at the time of permanent wilting.

TABLE 1.

Water distribution in tins when plants were permanently wilted.

Soil.	Water content, as a percentage of the oven-dry soil, in three sections of soil (uncorrected for roots).		
	Upper.	Middle.	Lower.
4537A. Curlwaa, N.S.W.	10·56±0·10	10·35±0·10	10·14±0·13
4459. Atherton, Qld. ..	19·49±0·15	19·63±0·11	19·64±0·10

S.E. for means of 5 replicates = ±0·12 (data pooled).

Results for surface horizons of varying texture and composition are given in Table 2. Five replicates were used in each case except No. 3927, in which one of the plants died. It appears that satisfactory results can be obtained with a relatively small number of replicates.

While the direct method for determining the permanent wilting percentage is undoubtedly the best, the plants require about six weeks for their development, and rapid indirect methods are therefore required. The indirect approach with the soundest theoretical basis depends upon the measurement of work done in removing water from the soil. This may be determined most conveniently by measuring the freezing point of the soil water.[2] Vallance and Wood[4] have used this method in their work on pineapple soils.

TABLE 2.

Permanent wilting percentage and other data for six soils.

Soil.	Permanent wilting percentage (P.W.P.).*	Moisture equivalent (M.E.).*	Ratio $\frac{\text{M.E.}}{\text{P.W.P.}}$
Waite Institute, S.A. (6272)	6·32±0·10	19·1	3·0
2 Waite Institute : 1 sand (mixture)..	4·35±0·15	13·5	3·3
1 Waite Institute : 2 sand (mixture)..	2·44±0·07	7·6	3·2
Curlwaa, N.S.W. (4537A)	9·95±0·09	21·3	2·1
Merbein, Vic. (3927)	10·27±0·08	16·3	1·6
Atherton, Qld. (4459)	19·44±0·09	27·8	1·4

* Expressed as percentages of oven-dry soil.

In an earlier indirect approach, the permanent wilting percentage* was calculated by applying a constant factor to the moisture equivalent of the soil. This factor has since been shown to be far from constant[5] and the data of Table 2 demonstrate the same point. However, use can be made of such a ratio if it is applied in a restricted way. Thus, once a ratio has been established experimentally for a few soils of one type, it can then be used to provide a quick estimate of the permanent wilting percentage for other soils of the same type. This method was used for irrigated sandy soils[1] at Waikerie, S.A., and it has been employed also for Canadian wheat soils[3] in which the seasonal trend of " available " water was being measured. Other single values such as sticky point would probably serve instead of the moisture equivalent.

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* Briggs and Shantz (see Veihmeyer and Hendrickson[6]), who developed the original direct and indirect methods, used the term " wilting coefficient " for results obtained in either way. Veihmeyer and Hendrickson introduced the term " permanent wilting percentage " to distinguish results obtained directly. There seems little need now for retaining both terms, provided results obtained indirectly are suitably indicated.

THE EFFECTS OF VARIOUS CONCENTRATIONS OF BORON ON THE GROWTH OF PINE SEEDLINGS IN WATER CULTURE.

The objects of the work reported in this paper were to confirm the description of boron deficiency symptoms on pine seedlings already published,[3] and to investigate the effects of various concentrations of added boron on the growth of *Pinus radiata* seedlings in water culture. The materials and methods were in general similar to those used before, except that the cultures were grown only in an open-sided greenhouse, and only during the spring and early summer, when growth was much faster than at other seasons. Under these conditions, growth was more satisfactory than in the earlier experiments, and there was no difficulty in reproducing the boron deficiency symptoms previously described. They did not appear in seedlings grown during the winter, when growth was very slow. Skok[5] states that reduction of photoperiod lessens the severity of boron deficiency symptoms in radishes.

Two nutrient solutions not used in the previous experiments were tried, but gave no better growth than the original,[3] which was used for the experiments reported in this paper. It was prepared from chemicals of analytical reagent grade, without special purification to remove traces of boron, and probably contained a low concentration of this element. All boron concentrations mentioned in this paper refer only to added boron, and are probably lower than the actual concentrations of boron involved. The boron was added as boric acid. Scofield *et al.*[4] state that a nutrient solution prepared by them from ordinary c.p. salts contained about 0·01 p.p.m. of boron, derived from impurities in the salts used. Mn, Zn, Cu and Mo were included in the solution used by the writer.

Seed of *P. radiata* was sown in damp sawdust in early spring. After six weeks' growth, the cotyledons were fully expanded, and primary needles were appearing. At this stage, evenly matched seedlings were rinsed with distilled water and were set up in soft glass preserving jars of nutrient solution, with the required concentration of added boron. All cultures were aerated daily, and the solutions were renewed about every ten days.

Minimal Boron for Normal Growth.

A preliminary experiment showed that there was no apparent difference between plants grown in a nutrient solution containing 0·05 p.p.m. of added boron, and those receiving 0·5 p.p.m. A further series was set up in solutions containing the concentrations of added boron shown in Table 1. After seven weeks' growth in water

TABLE 1.

Effects of Sub-optimal Concentrations of Boron on the Growth of Pinus radiata *Seedlings in Water Culture.*

Parts per million of added boron.. ..	0	0·005	0·01	0·05
Average dry weight in mgm. per plant (all differences are significant) ..	125	152	192	220
Boron deficiency symptoms	Marked.	Marked.	Very Slight.	None.

culture, the plants (including roots) were dried at 105° C. and weighed. By this time the tops ranged from about four to eight cm. in height above the cotyledons, and the length of the longest root varied from ten to twenty cm. The weights recorded in Table 1 are the averages of 25 or more plants in each series. There was a gradual improvement in the growth of roots and tops with increasing concentrations of added boron up to 0·05 p.p.m. Root growth was much better in the solution

containing 0·05 p.p.m. than in the others ; the improvement was chiefly manifested in a greater tendency to form small lateral roots. Boron deficiency symptoms described elsewhere[3] developed as shown in Table 1, and were severer in the more vigorous than in the weaker seedlings of each lot.

Toxicity of Excess Boron.

Evenly matched seedlings, germinated in sawdust and grown for two months in a solution containing 0·5 p.p.m. of added boron, were transferred to culture solutions containing the concentrations of added boron shown in Table 2. Twelve seedlings were grown at each concentration.

TABLE 2.

Development of toxicity symptoms on Pinus radiata *seedlings grown for two months in a nutrient solution containing 0·5 p.p.m. of added boron, and then transferred for six weeks to solutions containing higher concentrations of boron.*

Parts per million of added boron	0·5	2·5	5·0	10·0	20·0	40·0
Toxicity symptoms ..	None.	None.	None.	Slight.	Marked.	All plants dead.

During six weeks' growth in the latter solutions, boron toxicity symptoms developed to the degrees shown in Table 2. They began as a slight yellowing of the tips of the needles, followed by browning and drying, extending from the tip towards the base of each affected needle. There were no macroscopic symptoms on the roots. There was no significant difference in average dry weight between the seedlings from any two series, except that seedlings from the series receiving 40 p.p.m. of added boron were lighter than the others. The average weight of seedlings from this series was not comparable with the others, owing to the death of the seedlings at various stages of the experiment.

Under the conditions of these experiments, the approximate optimum range of boron concentration for the growth of *P. radiata* seedlings in water culture appeared to lie between 0·05 and 5 p.p.m. of added boron. The wide optimum range and relatively high minimum toxic concentration of boron for *P. radiata* are similar to those for plants classed as boron-tolerant by Eaton.[1]

Development of "Fused" Needles.

In the writer's previous paper on boron deficiency,[3] it was mentioned that a few of the older pine plants grown in boron-deficient solutions developed "fused" needles, resembling those occurring naturally on plantation-grown trees suffering from the physiological disorder known as needle fusion.[2, 6] It was also stated to be unlikely that the field symptoms of needle fusion were caused by boron deficiency. Similar "fused" needles have since occurred sporadically in other boron-deficient water cultures, but it has not been possible to produce them at will by withholding boron. It has subsequently become evident that the field symptoms of needle fusion are not caused by boron deficiency. Severely "fused" needles developed in abundance on the new growth of affected trees during the second season after treatment of the soil with borax or boric acid. These needles were shown by spectrographic examination to contain an abnormally high percentage of boron.

Chlorophyll and Starch Contents of Normal and Boron-deficient Needles.

Young[6] suggested that the field symptoms of needle fusion might result from a deficiency of carbohydrates due to faulty mycorrhizal development, and that the

temporary beneficial effect of boron and other minor elements on needle fusion trees might be due to their stimulation of chlorophyll formation and carbohydrate synthesis. In the hope of obtaining evidence that might have a bearing on the latter hypothesis, transverse sections were cut by hand from the needles of 16 pairs of pine seedlings grown by the writer in water culture. One of each pair was normal, having received adequate boron; the other was grown without added boron, and showed boron deficiency symptoms. In other respects, they were grown under uniform conditions.

As far as could be determined by the colour of the needles, and by microscopic examination of fresh unstained sections mounted in water, there was no consistent difference in chlorophyll content between the two groups. This does not exclude the possibility that a more accurate method of comparison might have shown a difference. An examination of similar sections stained with iodine-potassium iodide solution showed that in 12 of the 16 pairs there was more starch in normal than in boron-deficient needles; in three the position was reversed, and in one there was no apparent difference. The probability of a result equally or more unfavourable to the boron-deficient plants being obtained by chance alone is about 1 in 100. The difference in starch content was neither as marked nor as consistent as that between the starch contents of needles from healthy trees and those from trees with needle fusion.[2, 6]

Summary and Acknowledgments.

The growth rate of *Pinus radiata* seedlings in water culture increased with the concentration of boron in the nutrient solution, up to a concentration of 0·05 p.p.m. of added boron. Concentrations of 0·5 p.p.m. and over gave no further increase in growth rate.

Marked boron deficiency symptoms developed in seedlings grown in a nutrient solution containing 0·005 p.p.m. of added boron, and very slight symptoms in one containing 0·01 p.p.m. They did not occur in solutions containing 0·05 or more p.p.m. of added boron.

Boron toxicity symptoms developed in older seedlings grown in solutions containing 10 or more p.p.m. of added boron, but not in those containing 5 p.p.m. or less.

Needles from boron-deficient seedlings tended to contain less starch than those from seedlings which received adequate boron, but there was no obvious difference in chlorophyll content.

The writer is indebted to Mr. A. C. Oertel (Division of Soils, C.S.I.R.) for spectrographic determinations of the boron content of "fused" needles, and to Mr. K. F. Plomley (Division of Plant Industry) for preparing hand sections of normal and boron-deficient seedlings and assisting in their examination, also for help in the maintenance of the water cultures.

W. V. Ludbrook.

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(Received for publication, 4th April, 1942.)

CONTROL OF SPOTTED WILT OF TOMATOES.

Spotted wilt, a virus disease transmitted by the insect vectors *Thrips tabaci* and *Frankliniella insularis*, has during the past 15 years become the most destructive disease of tomatoes in urban areas of the New South Wales coast. In some seasons it has been an important source of loss also in inland districts. Plants are attacked in the seed bed, after setting out in the field, and in various stages of early and late maturity of the crop. Glass-house crops, with few exceptions, have escaped serious losses.

Pronounced differences in susceptibility to the spotted wilt virus are shown by commercial tomato varieties in a season of mild outbreaks but in a bad year nearly all varieties are liable to an incidence as high as 100 per cent., so that little use can be made of natural resistance in combating the disease. Early attempts to control the disease were based on the prompt detection and removal of diseased plants, and were unsuccessful. Later, it became clear, largely as a result of the work of Bald,[1] that most infection arose from adult thrips migrating to tomatoes from neighbouring weed and crop plants infected with the virus. Attention was directed then to the use of repellent materials and contact insecticides. After three experiments conducted in different seasons and testing a variety of repellents and contact insecticides, Bald reported unfavourably on this method of control. One of the writers (W.L.M.) also, in a preliminary experiment in 1936–37, tested the value of frequent applications of repellents. The dusts were applied three times a week, and significant differences were demonstrated between plots treated with a naphthalene-diatomaceous earth dust and untreated plots. The treatment later proved ineffective in a field experiment under conditions of severe infection.

In June, 1941, a conference convened by Dr. H. J. Hynes, Chief Biologist, N.S.W. Department of Agriculture, to consider the possibilities of developing a method of controlling spotted wilt led to the decision to test a new type of control—the employment of a poisonous bait against the thrips, which, by reason of its relative permanence, might succeed where repellents had failed. Tartar emetic was chosen for the purpose in view of the success achieved with this substance in the control of citrus and gladiolus thrips in U.S.A. The following is an account of an experiment conducted to test this material. After the test was under way a report was received from South Africa[2] announcing successful results in controlling spotted wilt by the use of tartar emetic.

Methods.

The experiment was conducted in randomised blocks in the vegetable garden at Hawkesbury Agricultural College, Richmond, in an area in which a high incidence of spotted wilt had occurred in the previous year. Each plot consisted of 80 Potentate tomatoes. Plots were sprayed with tartar emetic bait either once a week or twice a week, or were left untreated, each plot being replicated 8 times, giving an aggregate of 640 plants in each treatment. The crop was pruned and staked, and when water was available, was watered by furrow irrigation.

Spraying was commenced in the seed bed, the first application being made soon after the seedlings appeared above ground. The applications were repeated twice each week until the seedlings were ready to plant out in the field. Field applications were made once or twice each week and were repeated after rain. The solution used for seed bed spraying was 1 ounce of tartar emetic, 4 ounces of brown sugar and 4 gallons of water, but after planting out the amount of tartar emetic was doubled. The spray was applied as a fine mist to the seed bed by using a small atomiser, and in the field the spray was applied through a fine nozzle at a pressure of 100 pounds to the square inch. The method of application was by movement of the nozzle by the operator up and down each plant while moving briskly along

each side of each row. When and where necessary spray drift was intercepted by a hessian screen. Spraying commenced in the seed bed on 29th August, in the field on 25th September, and was discontinued in the field on 4th December, when the first fruit showed signs of ripening.

The crop was inspected almost daily and in the early stages spotted wilt plants were charted and then destroyed. After December, infected plants were no longer removed as many of them would mature marketable fruit.

Results.

The results are shown in Table 1. The application of tartar emetic bait greatly reduced the number of plants becoming infected in both series of treated plots. The average infection was 9 per cent. in the plots treated twice a week, 12 per cent.

TABLE 1.

Weekly Incidence of Spotted Wilt and Yield in Sprayed and Unsprayed Plots.

Treatment.	Number of Infected Plants.																			
	26 Sept.-2 Oct.	3 Oct.-9 Oct.	10 Oct.-16 Oct.	17 Oct.-23 Oct.	24 Oct.-30 Oct.	31 Oct.-6 Nov.	7 Nov.-13 Nov.	14 Nov.-20 Nov.	21 Nov.-27 Nov.	28 Nov.-4 Dec.	5 Dec.-11 Dec.	12 Dec.-18 Dec.	19 Dec.-25 Dec.	26 Dec.-1 Jan.	2 Jan.-8 Jan.	9 Jan.-15 Jan.	Total Number of Infected Plants.	% Infected Plants.	Yield.
																			lb.
Untreated ..	1	0	5	23	24	10	10	7	2	11	26	19	4	10	10	11	173	27	1,741
Sprayed once a week ..	2	1	4	5	5	5	6	3	2	4	7	13	0	6	5	9	77	12	1,896
Sprayed twice a week ..	2	3	4	1	9	4	3	2	0	2	6	3	3	8	3	5	58	9	1,904

in those sprayed once a week, and 27 per cent. in the untreated plots. The more frequent application, unexpectedly, did not greatly increase the degree of control. The difference in yields between treated and untreated plots is small and is accounted for by a number of factors. Chief among these are the extreme drought conditions under which the crop was grown, a lack of irrigation water when required and the high incidence of Fusarium wilt. The growth of the crop was consequently poor, and difference in yield between individual healthy and many late-infected plants which were not removed was small.

The incidence of spotted wilt in the control plots (27 per cent.) was low in comparison with experience in other years in the district. The drought conditions, which prevailed in the spring and resulted in reduced growth of weed hosts of the virus, may have been responsible for this reduced incidence. The baiting method of control has, consequently, not received a full test under severe epidemic conditions. There are indications, however, that the method would survive a test of this nature, judging by the wide differences in the number of plants becoming infected in treated and untreated plots during the two periods of maximum infection which are apparent in Table 1, namely 17th October to 6th November and 5th December to 18th December. It is assumed that during these periods large numbers of infective thrips were alighting on the treated plants and being satisfactorily dealt with.

Conclusion.

The experiment has been interesting in demonstrating the efficacy of vector control and useful in establishing the efficiency of baiting.

There is no reason to doubt that the baiting method of controlling spotted wilt would prove commercially profitable, provided tartar emetic could be procured at a reasonable price. It is considered that in areas in which the expected incidence would exceed 20 per cent., with a possible greater loss in some years, application of the spray once a week would be well repaid. Protection of plants in the seed bed would be profitable even under conditions of lower incidence. It is thought probable, on the basis of the concentration of tartar emetic used in control of the citrus thrips, that a suitable strength to adopt for tomatoes would be 1 ounce in 4 gallons.

The results have been supported by a number of tests conducted by commercial growers concurrently with our experiment, and in one case Paris green used as a substitute for tartar emetic showed promise.

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W. L. Morgan.
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Department of Agriculture,
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(Received for publication, 20th May, 1942.)

COMPOSITION OF SOYA BEANS GROWN IN NEW SOUTH WALES.

Although the Soya Bean has been cultivated in a number of countries in the world, little has been done to encourage its cultivation in Australia. From time to time small parcels of various varieties of beans from a few plants grown on the coast of New South Wales have been examined at the Sydney Technological Museum, but it was not until the year 1941 that an experimental cultivation by Mr. C. J. Frank, of Coramba, New South Wales, made available sufficient material to carry out systematic analyses of the varieties of beans grown.

Since the value of the Soya Bean is primarily as a food both for humans and farm animals, the important constituents are the oil and the protein. The latter constituent, also, is of importance in the production of plastic materials, and the oil is of considerable value for the manufacture of certain types of varnishes and enamel finishes.

The analytical results, as far as is known, are the first to be published for Australian grown Soybeans, and justify the belief that good quality beans can be grown in this country.

Results.

All samples were ground to a meal in a coffee mill to pass a 20-mesh sieve. The methods of analysis were similar to those used by Viljoen.[2] Since the main protein of the bean is stated by Osborne and Campbell[1] to be glycinin, the factor used for protein was 5·7. All results, excepting moisture, are calculated to a dry weight basis.

TABLE 1.

Composition of Soya Beans, grown at Coramba, N.S.W.

Variety.	Moisture per Cent.	Protein per Cent.	Oil per Cent.	Ash per Cent.
Dunfield	8·7	36·8	23·4	5·0
Ebony	9·2	39·6	20·9	5·4
Tenzan	9·7	38·3	20·7	5·2
Illini	8·5	38·4	18·9	5·3
Virginia	8·9	39·2	19·4	5·4
Mukden	8·8	38·4	22·8	5·4
Mandarin ..	8·5	44·6	18·3	5·9
Kingwa	9·0	39·1	19·6	5·4
Nice Stranger ..	7·4	38·4	21·2	5·2
Richland	8·9	38·1	22·0	5·8
Mean	8·8	39·1	20·7	5·4

It is interesting to compare the mean of these results with those given by Viljoen[2] as the average composition of varieties grown in Pretoria (South Africa), America and Manchuria as follows:

Country.	Moisture per Cent.	Protein per Cent.	Oil per Cent.	Ash per Cent.
Pretoria 1930–1931	6·4	43·8	17·4	4·9
Pretoria 1931–1932	6·8	40·4	18·9	5·1
America	7·5	40·2	18·1	5·5
Manchuria	10·0	40·8	17·4	5·4

It can be seen from these figures that the Australian grown Soybean compares very favourably with the American, South African and Manchurian beans.

Of the ten varieties examined, Mandarin, with the highest protein, has the lowest oil content, and Dunfield, with the lowest protein, contains the highest percentage of oil.

Although sufficient oil was not available for a detailed examination, the refractive indices of the ether-extracted oils were determined. They varied from 1·4730 to 1·4749 at 25°, which is well within the limits of the Australian standard specification for Soya Bean Oil, namely 1·4710 to 1·4750 at 25°.

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(Received for publication, 20th August, 1942.)

COPPER AND IRON IN AUSTRALIAN DAIRY PRODUCTS.

The effects of the presence of small amounts of copper and iron in catalysing oxidative changes in dairy products are well known, and a vast amount of experimental work on the effects of these metals on the keeping quality of milk and its products has been reported in literature by various workers. Further, in recent years considerable interest has been focussed on these metals, copper in particular, from the nutritional aspect.

During the past three years an investigation carried out at the Werribee Dairy Research Laboratories has furnished data regarding

(*a*) the copper and iron content of Australian dairy products including milk, cream, butter, milk powder, cheese, condensed milk and lactose ;

(*b*) the maximum amounts of copper and iron compatible with good keeping quality of milk and butter ;

(*c*) the partition of copper and iron during the manufacture of dairy products ;

(*d*) the efficiency of some anti-oxidants in milk and butter.

Copper and Iron Content. The range of values found for the amounts of copper and iron naturally occurring in milk were 0·05–0·14 p.p.m. and 0·30–0·77 p.p.m. respectively, with average values of 0·07 p.p.m. for copper and 0·50 p.p.m. for iron. Figures for the copper and iron content of commercial milk were higher due to contamination from equipment surfaces during handling and processing. Determinations indicated that over a period the naturally occurring copper and iron content of uncontaminated raw milk showed quite a significant variation. After a process of elimination it was concluded that the variations were due to physiological causes.

The range and average values for the copper and iron content of other products examined are given in Table I.

TABLE I.

The Range and Average Values for Copper and Iron Content of some Dairy Products other than Milk.

	Range.		Average.	
	Copper.	Iron.	Copper.	Iron.
Cream	0·06– 0·20 p.p.m.	0·60–2·60 p.p.m.	0·13 p.p.m.	1·20 p.p.m.
Butter	0·06– 0·40 ,,	0·52–2·40 ,,	0·12 ,,	1·20 ,,
Milk powder ..	1·25– 5·80 ,,	3·00–5·60 ,,	3·40 ,,	4·20 ,,
Cheese	0·44– 1·80 ,,	5·3 –13·8 ,,	1·10 ,,	8·30 ,,
Condensed milk ..	0·80– 2·50 ,,	4·00–6·00 ,,	1·80 ,,	5·20 ,,
Lactose	0·40–13·00 ,,	1·50–4·00 ,,	2·00 ,,	1·60 ,,

The maximum amounts of copper and iron compatible with good keeping quality of milk and butter were found to be as follows :

Milk : 0·20 p.p.m. copper ; 1·50–2·00 p.p.m. iron.

Butter : 0·18–0·20 p.p.m. copper ; 2·00 p.p.m. iron.

Copper was more active in catalysing oxidative changes than iron in either the ferrous or ferric state.

Although this phase of the work was not specifically extended to other dairy products, the results of determinations and practical observations indicated that if the metal present in condensed milk or milk powder exceeded 2·50–3·00 p.p.m.

copper and 5·00–6·00 p.p.m. iron, metal catalysed oxidative changes soon became evident in the development of undesirable flavours such as "tallowiness" and "oiliness".

A survey of the metal content of Victorian butter revealed that approximately 90 per cent. of the factories produced butter containing less copper and iron than the above amounts determined as being the limits for good keeping quality.

Plant surveys in those factories which consistently produced butter containing copper or iron in excess of the safe limits proved to be very effective in locating the units of equipment which contributed most to the contamination. Contamination in factories was chiefly in the form of copper from exposed copper surfaces while iron contamination occurred, in most cases, before the milk or cream reached the factory.

Partition of the two metals. A study of the partition of the two metals during the separation of milk and churning of cream indicated that each metal associates itself with the protein fraction. During the separation of milk the metal distributes itself in direct proportion to the protein and water in each fraction, while during churning the metal is concentrated in the butter, apparently in the form of a metal-protein complex absorbed on to the fat globule surface.

Anti-oxidants. A study of the anti-oxidative properties of a number of compounds demonstrated that "Avenex" powder, "Avenex" concentrate, sodium lactate and ascorbic acid acted as anti-oxidants in milk and butter. In butter the effect was transient, and disappeared in 4 to 6 weeks, after which the butters quickly oxidised.

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(Received for publication, 18th June, 1942.)

DUSTS FOR PROTECTING BEAN SEED AGAINST *BRUCHUS (ACANTHOSCELIDES) OBTECTUS* SAY.

Much loss of stored bean seed is experienced in New South Wales from the attack of bean weevil. Infestation commences either in the field before harvesting or in storage and successive generations of weevils breed in the seed and rapidly destroy it.

Fumigation with carbon bisulphide destroys the weevil but does not prevent reinfestation. In practice it is unsatisfactory and is not widely used. Growers have difficulty in providing gas-tight containers for the fumigation and in arriving at correct dosages. Overdoses affect the viability of the seed, while weak concentrations, giving poor weevil kill, often necessitate re-treatment. This second fumigation endangers the germinating power of the seed. Naphthalene at 2 to 3 ounces per bushel of seed provides fairly good control and is very commonly used. Its disadvantages are, firstly, that germination probably is affected under some conditions, especially when it is mixed with seed which has recently been fumigated, and secondly, the necessity of examining the seed every few weeks to add more naphthalene if required.

Recently, United States publications refer to the use of inert dusts mixed thoroughly with the seed for the prevention of weevil infestation in beans, but to date results in New South Wales conflict to some extent with American experience. Marcovitch[1] considers that the effectiveness of the dust depends upon its capacity to adhere to and completely cover every seed and so prevents newly hatched larvæ from eating their way into the seed. Hydrated lime, which he reported as being effective, appeared to be unsatisfactory under local conditions. One of us (W.L.M.) had used copper carbonate powder at the rate of 3 lb. per bushel of seed and found it effective. It seemed likely that a reduced rate of application would be effective and that some of the commoner and more easily obtained inert dusts would also give control. Accordingly the following experiment was arranged.

Method.

Uninfested Brown Beauty seed ($\frac{1}{2}$ lb.) and infested Canadian Wonder seed ($\frac{1}{4}$ lb.) were placed in an " Agee " jar and the requisite quantity of dust, as shown in Table 1, added. A lid was placed on the jar and the contents were shaken vigorously for about half a minute until the dust had become thoroughly mixed through the seed. The dusted seed was then poured into a stout muslin bag and 50 live bean weevils were added. Each bag of seed was finally tied securely and placed in storage for the three months between December, 1941, and March, 1942. There were four replications of each treatment. At the end of the period the Brown Beauty seed was separated out and the percentage infestation recorded. The mean percentage infestation for each treatment is given in Table 1. Germination tests were carried out with seed of the most promising treatments.

Results.

Bentonite, talc, magnesite and hydrated lime each at the rate of 1 lb. to the bushel of seed were ineffective. Basic copper carbonate, although it prevented infestation, could not be recommended, as it destroyed the germinating capacity of the seed. Copper oxychloride, copper carbonate and kaolin each 1 lb. per bushel, were effective, giving complete freedom from infestation. Copper carbonate at the rates of $\frac{1}{2}$ and $\frac{1}{4}$ lb. per bushel were almost as effective, infestation being extremely light. In these treatments all bean weevils were dead except in one replication of the $\frac{1}{4}$ lb. copper carbonate treatment. Sodium fluosilicate and Ceresan each 2 oz. to the bushel of seed were effective and would be valuable in commercial control.

At present they would be more costly than the other dusts, although Ceresan probably would have a fungicidal value.

TABLE 1.

Effect of Dusts on Bean Weevil after Three Months' Storage.

Treatments.	Quantity per Bushel.	Condition of Adults.	Percentage Infestation.	Percentage Germination of Beans.
Bentonite	1 lb.	Mostly alive.	98·6	—
Talc	1 lb.	Mostly alive.	54·9	—
Hydrated lime	1 lb.	Some alive.	30·0	—
Magnesite	1 lb.	Some alive.	30·5	—
Sodium fluosilicate	2 oz.	All dead.	4·0	94
Ceresan	2 oz.	Few alive.	1·9	—
Kaolin	1 lb.	All dead.	0·0	98
Copper oxychloride	1 lb.	All dead.	0·0	100
Basic copper arsenate ..	2 oz.	All dead.	0·0	0
Copper carbonate	1 lb.	All dead.	0·0	96
,, ,, ...	½ lb.	All dead.	0·1	—
,, ,, ...	¼ lb.	All dead except for a few in one replication.	0·2	—
Control untreated	—	Mostly alive.	93·1	—

An important factor in control by dusts is thought to be that every seed should be well covered to prevent entry by newly hatched larvæ.

The effective dusts do not prevent larvæ already in the seed before dusting from developing and emerging as adults, but they destroy adults and prevent newly-hatched larvæ from entering well-dusted seed.

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The Australian Institute of Agricultural Science

MEETINGS OF COUNCIL.

April Meeting.

A meeting of Council was held in the Board Room, Department of Agriculture, Melbourne, on 13th April. *Present*: Mr. G. W. Leeper (V.), in chair, Dr. A. E. V. Richardson (S.A.), Dr. H. C. Forster (W.A.), Mr. J. L. Provan (Q.), Mr. F. S. Crawford (T.), Mr. R. W. Prunster (A.C.T.), the Honorary Treasurer, Mr. R. L. Twentyman, and the Honorary Secretary, Mr. A. J. Vasey. Apologies were received from Mr. G. H. Vasey (N.S.W.) and the Assistant Honorary Secretary, Mr. R. D. Croll.

Among correspondence received was the Report of the Business Manager of the Journal and audited statement of accounts covering the publication of the four numbers of volume 7, a summary of which is given below.

Annual reports were also received from the Queensland and the A.C.T. Branches.

The current financial statement showed a balance at bank of £237 5*s*. 2*d*.

Report of the Business Manager of the Journal for Volume 7 (1941).

The effects of the present war have been felt by the need to make several changes of agreement with the printer and the advertising agent during the year. There has been an increasing cost of publication, and, because of enlistments and other movements of members, a continual adjustment of the mailing list. Early in the year, the printer indicated that the cost of publishing the Journal would increase by approximately £30 per annum, and Council's approval for the extra expenditure was sought. Under the prevailing conditions, however, Council requested that expenditure on the Journal be kept within £160 for the year.

Various economies were adopted to reduce costs. The area of the page occupied by print was increased, closer setting of the lines of type was resorted to, and a lighter quality paper used. The audited statement shows that a saving was also made on setting tables and making blocks, in the effort to reduce expenditure. The result has been that, while appearance has been sacrificed, the number of words printed in Volume 7 closely approximates the pre-war volumes. The quality of the cover has unavoidably declined.

The paper ration for the Journal was pegged at 25 per cent. reduction on previous usage in April, 1941.

The current charges for the Journal, published on the cover, were approved by Council in January.

Reprints of 24 papers, amounting to 3,220 pages, were purchased during the year, compared with 33 papers, totalling 5,550 pages, from the previous volume.

During 1941 there were three new subscribers and one institution ceased to subscribe, bringing the total subscribers for the year to 42.

The audited statement of accounts indicates that the net cost of publishing Volume 7 was £159 2*s*. 11*d*., which is just within the figure of £160 fixed by Council early in 1941 as the maximum expenditure.

July Meeting.

The Council of the Institute met at the School of Agriculture, the University, Melbourne, on 13th July, 1942. *Present*: Dr. H. C. Forster (W.A.), Mr. R. W. Prunster (A.C.T.), Mr. F. S. Crawford (T.), Mr. J. L. Provan (Q.), Mr. G. H. Vasey (N.S.W.), Mr. J. K. Taylor (S.A.), the Hon. Treasurer, Mr. R. L. Twentyman, the Hon. Secretary, Mr. A. J. Vasey, and the Asst. Hon. Secretary, Mr. R. D. Croll. Apologies were received from Mr. H. A. Mullett (V.) and Dr. A. E. V. Richardson (S.A.). By invitation and arrangement Mr. J. K. Taylor represented the South Australian delegate. In the absence of the Chairman, Mr. Mullett, Dr. H. C. Forster was voted to the chair. The meeting directed that a record of appreciation for the services rendered by Mr. G. W. Leeper as chairman of the Proxy Council during the period he was the Victorian delegate, be made in the minutes.

A majority was reached in favour of the original A.C.T. Branch motion, which read :

> That the Australian Institute of Agricultural Science should strongly advocate the immediate establishment of an organisation to undertake research in agricultural economics.

and the manner of taking appropriate action was discussed.

The Report of the Business Manager of the Journal (Dr. N. S. Noble) and the Statement of Accounts covering Volume 7 were unanimously adopted. The Hon. Secretary was directed to

write to Dr. Noble, expressing the Institute's appreciation of his management of the Journal and thanking him for his comprehensive and lucid report. In subsequent discussion it was pointed out by several members that the publication of the Journal without advertisements was an ideal now well within the financial capacity of the Institute.

The following applicants were admitted to membership : *to corporate membership* in New South Wales : Dr. Lilian Fraser, Messrs. J. M. Coleman, R. H. Arnot, W. H. Pawley, L. C. Birch, B. C. Gardiner ; in Queensland : Messrs. E. B. Rice, F. W. Blackford, J. H. Saint-Smith ; in South Australia : Miss C. M. Eardley, Mr. C. E Haines ; in Western Australia : Mr. A. R. Prater. *To student membership*, in Western Australia : Messrs. W. J. Bettenay, I. P. Bonnerup, E. J. Hilder, R. F. Pugh, A. J. T. Marshall, S. T. Smith, W. R. McKeown.

Transfers of membership included Dr. I. F. Phipps (S.A.) and Mr. N. H. Shaw (A.C.T.) to the Victorian Branch, Mr. R. A. Paul (V.) to the Western Australian Branch and Mr. C. M. Donald (A.C.T.) to the New South Wales Branch.

A number of comments were received from delegates on the action taken by the New South Wales Branch in submitting a report of a sub-committee, adopted by the Branch, to the Federal authorities. As a result the following motion was framed for discussion at a following meeting :

> Where it is proposed to approach governmental or other authorities on matters affecting more than one Branch and its members that approach shall be made only by or with the authority of the Council of the Institute.

In June, the Institute was invited by the Director-General of Manpower to nominate Scientific Manpower (Agriculture) Advisory Committee and Sub-Committees. The personnel of State Sub-Committees was intimated by each State Branch, and the Council decided to act for the time being as a central committee.

The current financial statement showed a bank balance of £233 2*s*. 2*d*.

The Honorary Treasurer, Mr. Twentyman, submitted the audited statement of accounts and balance sheet of the Institute for 1941, which will appear in next issue of this Journal.

The Register of Members at 31st December, 1941, showed a total of 464 corporate members and 25 student members. The former showed an increase of six during the year. The distribution of membership among the branches at the close of the year was as follows : Australian Capital Territory, 32 ; New South Wales, 117 ; Queensland, 57 ; South Australia, 58 ; Tasmania, 17 ; Victoria, 117 ; and Western Australia, 58.

Nine members in Victoria, ten in New South Wales, five in Queensland, two in South Australia, three in Western Australia and one in the Australian Capital Territory have been excused subscriptions because of military service.

In their report, the Auditors specially noted that the members' register and other books of account had again been well kept.

MEETINGS OF BRANCHES.

Australian Capital Territory Branch.

At the annual general meeting, discussion arose on the machinery of the Institute for dealing with projects. The general feeling of the meeting was that it was almost impossible to get the Institute to support projects submitted by individual branches.

A subsequent general meeting held on 29th April was devoted to further discussion of Institute machinery, including Proxy Council. It was felt that the Institute had failed to develop an Australian outlook, because of the tendency of individual branches to consider matters from a State, rather than a Federal angle.

In the matter of the Journal there was considerable difference of opinion as to whether its publication was warranted under existing circumstances. Most members thought that it should contain more matters of interest to members apart from the scientific papers. It was suggested that meetings of Council be published, as well as a series of challenging articles which would endeavour to promote a more Federal outlook.

Two general meetings, held on 23rd June and 13th July, were occupied with discussions arising from the invitation of the Director-General of Manpower for the formation of a sub-committee to advise the Manpower Authorities on the enlistment, call-up and employment of agricultural scientists. Members were unanimous in their approval of the fact that the Institute had been recognised as a Federal body representing the interests of agricultural scientists, but there was some discussion as to whether the sub-committee would serve any useful function. On a majority vote it was decided to fall into line with other Branches and appoint a sub-committee. The following members were elected : Dr. B. T. Dickson, Dr. J. G. Davies, Dr. C. Barnard, Mr. E. McKinnon and Mr. F. J. Gay.

A committee meeting was held on 3rd July to discuss the New South Wales report on the organisation of agriculture for war. Although there was a feeling amongst members that the action of the New South Wales Branch in forwarding the report directly to the Prime Minister might have been unconstitutional, it was generally considered that there was justification for their action because of the existing difficulty of getting the Institute to act with an Australian-wide outlook.

New South Wales Branch.

A joint meeting of the New South Wales Branches of the Institute and the Australian Veterinary Association was held at the Veterinary School, Sydney University, on 2nd June. The main business was consideration of a report on " Extension Services " which was prepared by a joint committee of the two bodies elected in May of the previous year. Dr. R. M. C. Gunn occupied the chair, and the main findings of the report were discussed by Dr. H. R. Carne and Mr. H. Bartlett.

In the subsequent discussion, it was clear that the need to apply the results of research by a special extension service was widely appreciated, and a number of suggestions on method were made. Among these the opinion that extension should not be divorced from administrative work was expressed by several contributors to the discussion.

The report was adopted as an interim report and the committee empowered to continue to make investigations and prepare a short report for the present circumstances and a broad plan for the future.

At a second joint meeting, held at Science House on 7th July, " War-time Fodder Conservation " was discussed. Dr. H. J. Hynes occupied the chair. There was a very good attendance, including representatives of the Fodder Conservation Board and farmers' organisations.

The principal speakers and their subjects were as follows :

Hon. E. J. Eggins, Chairman of Fodder Conservation Board and Chairman of Stock Dispersal Committee : " National Aspects of War-time Fodder Conservation."

Mr. A. W. S. Moodie, Senior Agrostologist : " Conserving Grassland Products." (Paper read by Mr. McClymont.)

Mr. L. Judd, Senior Agricultural Instructor : " A Group System of Fodder Production and Conservation."

Mr. H. J. Geddes, Lecturer in Animal Husbandry, McGarvie Smith Animal Husbandry Farm : " The Economic Basis of Fodder Conservation in Wartime."

After the main speakers had dealt with certain important aspects of this war-time problem a vigorous discussion followed. The discussion centred around the economics of fodder conservation and in most cases dealt specifically with the allocation of government aid to producers. On account of the great number of visitors present, it was not practicable to have a motion passed, but several suggestions worthy of consideration were given during the evening.

Queensland Branch.

A meeting held on 21st May was devoted to " Tropical Agriculture ". Mr. J. L. Schofield, who was for several years manager of a rubber and oil palm plantation in Johore, dealt with methods adopted for the improvement of yield in those crops. Experiments dealing with the effect of controlled pollination and phosphate applications on fruit setting in oil palms were described.

In connection with rubber, it was pointed out that the yield of seedling trees of *Hevea brasiliensis* varies tremendously, and it is common for 70 per cent. of the yield of an area of seedlings to be produced by only 30 per cent. of the trees. The first step in plant improvement is the selection of high yielding mother trees, from which slips are taken and grafted on to ordinary seedling stocks. Each mother tree is thus the starting point of a new clone, large numbers of identical trees being produced by grafting buds on root-stocks of seedlings of ordinary trees. The yield of *Hevea* has been increased enormously. While the normal production is 400 to 500 pounds of dry rubber per acre per annum, some clones and clonal seedlings yield over 2,000 pounds.

The President, Dr. D. A. Herbert, dealt in entertaining fashion with agriculture in the Philippines, which is essentially rice culture. The mountain peoples have been obliged to adopt a special form of agriculture and, although very primitive, they have achieved amazing results in terracing mountain slopes. Where a rice paddy cannot be made by terracing, sweet potatoes are grown as a communal effort. The mountain people have no idea of crop improvement practices such as selection and plant protection.

The lowland peoples also subsist largely on rice, and a tremendous amount of labour is involved in hand setting of seedlings, in hand weeding, and in hand harvesting. Many of the

farmers have fish in their rice paddies and these are collected as the water is drawn off towards crop maturity. Usually two varieties of rice are grown in admixture, in case one variety fails. Hybridisation occurs and sometimes gives rise to new varieties. Often bearded varieties, although hard to mill, are preferred to beardless varieties, because they are not so liable to attack by birds.

The main crops besides rice are manila hemp and coconut, while a variety of tropical fruits is grown.

On 17th July an address was given on " Chemical Substitution of Agricultural Products " by Mr. I. R. C. Bick, Lecturer in Chemistry at the University of Queensland. Mr. Bick dealt at length with rubber substitutes and discussed quinine and quinine alkaloids.

The key to the understanding of the chemistry of rubber was the knowledge that isoprene is the fundamental structural unit. Synthesis was accomplished first in France in the 1870's by treating isoprene with concentrated hydrochloric acid. Since the supply of raw materials from which isoprene could be obtained was so limited, chemists sought some other substance which could be polymerised to give rubber. One of the first found was dimethylbutadiene, which differs from isoprene in having a methyl group instead of a hydrogen atom. This substance can be obtained from acetone and polymerises to a substance with rubbery properties. Methyl rubber was produced in large quantities in Germany in 1917-1918.

After the 1914-1918 war, interest in synthetic rubber diminished, but was stimulated during the rubber boom about 1925. This time a third type of unit occupied the stage—butadiene. This resembles isoprene and can be polymerised to give a rubbery substance like caoutchouc. Previous to the present war, the main developments in the butadiene type of rubber were in Germany and later in Russia. The German chemical industry produced a series of rubbers to which they gave the trade name " buna ", which was gradually improved, and by 1939 was claimed to be superior to natural rubber in most of the desired properties of rubber.

In 1931 the discovery in U.S.A. of chloroprene, closely related to isoprene, but with an atom of chlorine in place of a methyl group, was announced. Chloroprene polymerises naturally without addition of any agent to a rubber material called neoprene. Although not as cheap as natural rubber, neoprene is more resistant to the action of mineral oils, and also is more heat resistant, and has competed with natural rubber for several years. One other development of note was the production of a series of substances known as thiocols, which could be obtained by treating chlorinated organic substances with sodium polysulphide. The thiocols have good rubbery properties and are particularly resistant to heat.

Scrap rubber is of importance at the present time and is useful when compounded with the natural product. The chief reclamation process is a treatment with sodium hydroxide and steam, a process known as devulcanisation.

In general, then, there is no reason why industrial nations should not be able to prepare sufficient synthetic rubber to meet the world's requirements.

Mr. Bick then dealt with quinine and quinine alkaloids. The bulk of the world's production is in the Netherlands East Indies, and is not available to the Allies. The chemist is faced with a difficult problem owing to the complicated chemical structure of quinine, which has not yet been prepared synthetically.

For a long time chemists have tried to find a suitable substitute. Early in the 1914-1918 war the German Bayer Company prepared for testing some 12,000 compounds resembling quinine in structure. They announced the anti-malarial plasmaquin in 1926. It is, however, not a substitute for quinine, but rather a complement to it. About 1931 the Bayer Company announced another anti-malarial—atabrin—which can be used as a substitute for quinine. The raw materials for the synthesis are coal tar products.

South Australian Branch.

On 29th June Mr. W. S. Kelly addressed the South Australian Branch of the Institute on " British Farming 1942 ". He gave an account of the efforts being made to stimulate and direct agriculture in Great Britain. Interesting features of the scheme are that general policy is determined by the central authorities but the responsibility for local organisation is in the hands of county committees.

On 21st August the South Australian Branch held a discussion on " Organising Australian Agriculture for War ". Members had been advised to study the report prepared by the sub-committee of the New South Wales Branch before coming to the meeting. Four speakers led the discussion. Mr. W. J. Spafford described the constitution and achievements of the Agricultural Council, the Standing Committee for Agriculture, and the Australian Food Council. Mr. Spafford praised the work of the Agricultural Council, giving instances of tangible achievements, particularly with reference to certain aspects of the dairy industry and the control of margarine. He said that the political value of the Agricultural Council was very great. When there was unanimity among the States, cooperation had always been forthcoming from the Commonwealth. The Agricultural Council meets only twice each year. Mr. Spafford agreed, in answer to a question, that action had sometimes been held up by failure to reach unanimity.

Mr. A. G. Strickland described the functioning of the several Commonwealth departments and their associated boards in so far as they concerned agriculture.

Professor J. A. Prescott gave an outline of the organisation of research and administration in agriculture in Great Britain. The organisation in Scotland was dealt with in greater detail. Important features were the way that the Department of Agriculture functions through decentralised stations located in appropriate regions, and the prominence of agricultural economics.

Mr. J. K. Taylor dealt with the organisation of agricultural research and administration in U.S.A. In the United States, the Department of Agriculture undertakes the work which in Australia is the partial responsibility of six or seven Commonwealth departments and six State departments. The States have their own organisations for education, extension and research, but these organisations work side by side with officers of the Federal Department of Agriculture. Very few changes were needed to meet wartime needs, as agriculture was already being controlled and guided before the war. The Bureau of Agricultural Economics is a prominent feature of the U.S. Department of Agriculture.

The meeting directed the State Committee of Management to draft a suitable resolution for presentation to the next general meeting.

Tasmanian Branch.

The seventh annual meeting of the Tasmanian Branch of the Institute was held at the Department of Agriculture on 26th June. The meeting was arranged at short notice and owing to the absence, through illness, of the President the usual presidential address was omitted. The Vice-President, Mr. R. A. Sherwin, took the chair.

The Honorary Secretary read his report on the activities of the Branch during the past year. He reported that three general open meetings had been held in 1941 and had been attended with great success. He regretted that through pressure of work it had been impossible to continue this practice during the latter part of the year. He also reported a completely financial membership and a credit balance at bank of £21 3*s*. 1*d*. for the year.

At the conclusion of the annual report, office-bearers for the present year were elected. These were as follows: President, Mr. J. T. Armstrong; Vice-President, Mr. E. F. Fricke; Honorary Secretary-Treasurer, Mr. H. V. Rees; Committee Members, Dr. J. W. Evans, Mr. H. R. Dickenson; Sub-Editor, Miss M. Gray; Auditor, Dr. R. A. Scott.

Victorian Branch.

On 19th June members were addressed by Mr. W. S. Kelly, a South Australian farmer and pastoralist, and member of the Tariff Board, who had just returned from England. For the past two years he had given his services to the British Ministry of Agriculture and farmers' organisations. He served also as Australian representative on the International Wool Secretariat in London. The subject was "British Farming, 1942". Mr. Kelly reviewed the remarkable changes that had taken place in British agriculture in the last two and a half years and expressed the opinion that increased efficiency would be one of the compensations for war. Local committees in conjunction with the Ministries of Agriculture and Food were coordinating production of essential requirements, and farmers were given every encouragement. On the other hand, efficiency was a necessary qualification for continued occupation of a farm. Non-cooperation or laziness meant the farmer making way for someone else. Farm surveys on a large scale had been most helpful in planning production.

There was a marked tendency towards inflation of farm produce prices, continued Mr. Kelly. Wheat was 8*s*. a bushel, barley 33*s*.; the latter figure out of all proportion to other grains. Barley was the only grain price not pegged. Lambs brought 17½*d*. lb., milking cows £60, draught geldings £80, while land values had increased by 50 per cent. Dairy herds were well maintained and, of necessity, there had been a large increase in home grown foods. Short term leys were replacing the old, and often neglected, permanent pastures. There had been a remarkable development of light lands previously regarded as useless. Here, large scale vegetable growing was booming. In conclusion, Mr. Kelly pointed out that multiple ploughs, Australian-made drills and headers, rotary manure spreaders and stump jump ploughs were being used on a large scale. This represented a big change. More than half (57 per cent.) of Britain's farms were under 50 acres, and two-thirds of the remainder were under 150 acres.

Members also attended the following meetings of the Melbourne University Agricultural Society. On 26th June the talk was entitled "Wheat Milling and Baking, Past and Present, with Recent Advances", and was given by Mr. G. B. Harris and Mr. R. A. Bottomley, M.Sc., both of Messrs. W. S. Kimpton and Sons, flour millers.

"Zebu Hybridisation—Eight Years' Work in Australia" was the subject of the paper prepared by Dr. R. B. Kelley and presented by Mr. A. J. Vasey on 24th July. A summary of the paper appears under Current Notes and News in this Journal.

Western Australian Branch.

" War-time vegetable production in Western Australia " was discussed at a meeting held on 7th May. Mr. G. K. Baron Hay opened the discussion with a review of the changes in demand for agricultural produce since the war began. He indicated that on account of the fighting forces' demands on manpower and the presence in Australia of Allied forces, vegetable production was likely to fall short of requirements. The organisation set up under the National Security Regulations to alleviate this position was then discussed. Dr. T. C. Dunne dealt with problems of vegetable seed production, emphasising Australia's previous dependence on imported supplies. Climatic difficulties and economic factors have been deterrents to seed production. The cost of seed is normally such a small proportion of the gross value of the vegetable crop that it is difficult to see why much higher prices for seed cannot be paid to stimulate its production. Contracts have been made with growers in Western Australia to produce seed, and it is hoped that sufficient supplies for 1942 will be produced. Mr. E. T. Morgan discussed some of the practical problems involved in increasing vegetable production, particularly those associated with labour and financial difficulties. He critically discussed the unwillingness of the Army authorities to make use of existing organisations and brokers to finance the production of vegetable crops. It was pointed out that in Western Australia it is usual for potato growers to be financed for fertiliser and seed supplies through merchants and brokers.

On 3rd July, Mr. F. L. Shier, Past-President, addressed a well attended meeting on " The Fat Lamb Industry in Western Australia—Its Development and Problems ". The address is published elsewhere in this Journal.

Current Notes and News

Zebu Hybridisation: Eight Year's Work in Australia.

A paper entitled as above was presented by Mr. A. J. Vasey on behalf of Dr. R. B. Kelley, Animal Geneticist of the C.S.I.R., at a recent meeting of the Melbourne University Agricultural Society.

Dr. Kelley opened his paper by showing that the stocking of tropical Australia with British breeds of cattle in the early days was wholly fortuitous and in light of the experience of recent years indicated an over-estimate of the potentialities of the country. Due to the unsuitability of the climate and the pastures, the fattening of cattle of these breeds in many areas was unprofitable. Agrostologically, it had proved impossible to the present to modify the environment from the nutrition standpoint. The other alternative was to modify the breed. As the country could not be brought " up " to the cattle as had been done in the dairying districts of southern Australia by pasture improvement and irrigation, the cattle must be brought " back " to the country.

Examination of the methods of cattle breeding and husbandry in similar climatic zones in other countries of the world showed the importance of Zebu cattle either as the native breed (Asia, Africa), or as importations (North and South America). The productivity of Zebu type cattle as dairy or beef animals, though satisfactory to the native peoples, does not come up to European standards. Hybridisation with the improved breeds of the Northern Hemisphere has therefore been undertaken, (*a*) to raise the productivity of the indigenous cattle in those tropical areas where these are of Zebu type ; (*b*) in tropical areas where there are no indigenous cattle, to produce a breed better suited to the environment than the European breeds. Zebu hybridisation seeks, by selective breeding, to combine in the hybrid animals the advantageous characters of the European and the tropical types.

There is nothing new in such an amalgamation of characters. It was the method which produced the Australian Merino sheep. The difference between the two conceptions is that the sheep men worked with breeds all of the same species while Zebu hybridisation involves the crossing of two different species. The method of amalgamation is equally applicable to cattle and the material available is adequate for the purpose.

It is interesting to note that up to 1933 Australia was the only tropical country where active investigational work along these lines was not in progress. In that year, however, an agreement was entered into between four north Queensland pastoralists and the C.S.I.R., whereby the former undertook to provide the funds for the purchase and transportation of Zebu cattle from the United States to Australia, to provide British cattle for hybridisation and to maintain these cattle and their progeny. The Council undertook to organise and supervise their experiments in such a manner that as much relevant data as possible could be collected. Later in the same year eighteen Zebu cattle and one cross-bred bull were landed in Australia and were distributed to the cooperating pastoralists early in 1934.

Broadly, the object of the experimental work has been to determine what advantages, if any, would accrue to the tropical Australian beef industry from the introduction of Zebu blood and the proportion of Zebu likely to be most advantageous. This work has now continued for eight years and by 1941, from the 19 head of imported cattle, a population of 7,756 hybrids had arisen.

The results of the observations have shown that very definite advantages have been gained in the hybrid in regard to hardiness, tick repellence, free movement and intelligence, and carcase type. In the yards before slaughter the appearance of the hybrids is deceptive. Owing to the length of the bones of the lower leg, they appear " rangy ". On the hook, however, the carcases are most attractive and grade out very well, the quality of the meat being excellent. The most desirable proportion of Zebu in the hybrid varies from one-quarter to one-half according to circumstances.

Very strong evidence has been obtained that the hybrid cattle reach slaughter weights suitable for the chilling trade at three years of age or less, that is, one year younger than the British breeds. This earlier maturity could mean eventually an increase of 70,000 bullocks in the annual outturn from the beef herds of tropical Australia without affecting the number of cattle carried per square mile of country. There are indications also that the cast for age breeding cows will have a considerably higher value than those of British breeds.

Dr. Kelley concluded by describing the work as " a realistic endeavour to investigate an ecological problem of economic importance by a biologically and geographically sound process which was in accord with a world-wide scientific movement ".

" Reconstruction and the Land."

Mr. W. S. Kelly, a prominent South Australian agriculturist and member of the Tariff Board, who has been closely associated with agricultural development in England during his residence there in the past two years, has forwarded the following discussion and comment on Sir A. Daniel Hall's latest book, *Reconstruction and the Land*. The book was published by Macmillan and Co., London, in 1941 at 12*s*. 6*d*. sterling.

Reconstruction and the Land justifies Sir Daniel Hall's great reputation as an Agricultural Scientist and as a leader in land administration. Of the many recent books dealing with British agriculture, this work stands out as the most important since that written by Astor and Rowntree some six years ago. Hall's chief aim in writing this book is to advocate the nationalisation of all British agricultural land. Before he arrives at this advocacy, however, Hall closely analyses the past and present conditions of British agriculture, and this analysis is the most valuable portion of the book.

Hall's vivid style of writing makes very interesting the short historical survey which he gives of British farming. He tells of the old manor farming and the open fields where the strip farming prevailed, a system which still strongly influences farming practice in England today. Later came the enclosures, bringing both hardship and improvement, making possible the wider cultivation of fodder crops and the adoption of rotation farming. Prices of farm products rose to a great height during the Napoleonic wars, and as late as the sixties of last century wheat held for ten years at an average of 51*s*. 8*d*. per quarter. That was the so-called " Golden Age " for British farming, when a sack of wheat would pay two weeks' wages ! There follow accounts of slumps and recoveries so sadly familiar to farmers all the world over. The price of wheat rose again during last war to 70*s*. per quarter, and this price held for the years 1917 to 1921. This high price caused the value of land to rise, and permitted many landlords to sell out at fictitious values, so that, when the price fell to 47*s*. 2*d*. in 1922, the farmers who had purchased at extravagant values were hardly hit. But much worse was to follow, for by 1934 the price had crashed to 20*s*. 9*d*. and grain farmers the world over were in trouble together.

Following this background the book depicts the structure of British agriculture just before this war began. There were 440,000 holdings large and small. Ignoring those below five acres, 57 per cent. were still less than 50 acres. These are termed " small holdings " as compared with farms. Farmers are defined as " men who make their living by employing labour upon the land ". It is thought that their number is about 150,000 and in 1938 a few less than 700,000 workers were classed as farm labourers, which shows British farms to comprise of holdings on the average worked by the farmer with four or five labourers. Of these farms only 57,000, or roughly one-third, are over 150 acres. Hall is convinced that there are far too many small farms and that this makes efficient use of modern farming plant impracticable. British farmers require about three men for 100 acres. Compare this with Australian conditions, where the farmer and one man work a mixed farm of 500 to 1,000 acres. On the other hand, in Denmark six men are employed for 100 acres, in Germany 12, and in Belgium 13, men for 100 acres.

Approximately 10 per cent. of the farming land of England is already publicly owned. It is of interest to note in passing that the Forestry Commission owns nearly one million acres and that the Universities of Oxford and Cambridge conjointly own over one-quarter million acres, while the Ecclesiastical Commissioners own nearly as much.

The Land Tax, an Australian is interested to learn, is a " small fixed charge of long standing " and represents little or no burden. Tithes, formally the cause of much bitterness, are now a fixed charge and are to be brought to an end in 1996. Values of land fluctuate both from year to year and between one farm and the next, but Hall sums up this matter by saying " Outside the districts where intensive farming can be pursued, the price of ordinary agricultural land has, of late years, been about £20 to £30 per acre. As high as £40 and as low as £10 has been paid according to the buildings, conditions and situations." Under war conditions prices have risen considerably above this figure. Most of the land is farmed by tenant farmers and the value of stock and plant is commonly about £10 an acre, although the figure would be much higher for dairy farms. This, with £2 as working capital, brings the tenant's capitalisation on a mixed farm to about £12 and over per acre.

Fine work has been done in the past to build up the fertility and to reclaim much of the farm land of England. Many examples are given, including that of Rothamstead Estate, where the top spit of soil of some of the home fields contains as much as 3 per cent. of carbonate of lime. " Dene Holes " show this lime had been quarried and applied at some time long since, records showing that it must have been done before last century. Allowing for the rate at which the chalk is being dissolved, the land must have received at least 70 tons of chalk per acre, a prodigious dressing considering the lack of equipment in those early days. Fields that were not so treated have been failures and are overgrown with bush. There is much evidence, also, of heavy marling of light sandy lands and of claying of the Fens, the clay having been dug from the subsoil and spread over the peaty surface, thus giving more consolidation and fertility. Truly much labour and care have been devoted to building up the soils of England ! And the maintenance of fertility is still generally looked upon as the farmer's first duty. Yet in spite of all this, much land has been allowed to go derelict. Illustrations are given of land, which was drained at great expense and built up into fine fertile farms during last century, having become so neglected as now to be waterlogged, overgrown with rubbish and of no value.

Hall has no special blame for any one class. He thinks that the landlord has tried to do his part, though of late years he has not been equipped to guide and direct the farming of his estate. Often his net income from rents has been low. Farmers vary as much in efficiency as do their farms in fertility, yet, on the whole, they are industrious and not inefficient. The labourer has lost initiative and keenness because, over the years, his low wage compared with that of the artesian has caused a drift to the towns of the more enterprising. Yet the stock is right and would greatly improve with better conditions and outlook. This should now be secured if the increased wage of £3 per week can be maintained.

A careful study is made of the earnings of farmers. This differs between both districts and individual farms. Many farmers were doing well in the later 'thirties but Hall concludes that farming, taken as a whole, has been unprosperous and has declined over the last seventy years, the rate of decline being more severe during the last twenty years. This decline is generally attributed to neglect by the succeeding governments, who are often charged with having " let down " the farming community. Yet Hall shows that the amount of government assistance over recent years has been heavy indeed. A table is printed (page 42) which purports to show that the State assistance to agriculture for 1938-9 exceeded £41,000,000. This cost is considered excessive and represents between 20*s*. and 30*s*. per acre of cultivated land, which is more than its rental value. Hall concludes this section by saying (page 112), " The current agricultural policies of subsidies and protection are not likely to have much effect in improving the technique of British farming nor in modifying its organisation. On the contrary, they tend to keep in being old methods and indifferent farming. They favour scarcity policies of restricting production to the quantity that can be sold at a high price. In so far as subsidies are not absorbed in increased rents they give excessive profits to good farmers in order to enable bad farmers to live."

The solution that Hall propounds is for the purchase of all farm lands by the State " at a price based upon the annual valuation for income tax under Schedule A, the payment being made in long dated government stock ". He argues, with much spirit, the need of this drastic change and sets out his ideas of the organisation to control both production and marketing. He is convinced that the present day landlords are not equipped to give the assistance that is essential for farming to become efficient. If the State is to find the money to improve the farms, this will largely go to the benefit of the landlord if the land is owned as at present. He insists that the State should merely act as landlord and that tenant farmers should continue to farm the land. The farms must be re-grouped, taking care of the lie of the land, thus greatly facilitating all the farming practices. Most of the smaller farms would be eliminated and all farms laid out in sizes suitable to the type of agriculture of the area.

This carries the whole question into a political sphere where an Australian cannot expect to know all the facts. Yet one wonders whether the problem of markedly varying costs, which make the matter of costs and prices so difficult to adjust at present, will not continue to apply. Farms will still vary in fertility and the efficiency of farmers will still differ as one star from another. Even if we are not convinced by the proposals, the thesis demands very close study, for Hall makes out much too strong a case for it to be lightly put aside. The book must be studied by all who are called upon to find a way out of the between-wars madness of restrictions and poverty midst potential plenty.

Mr. W. T. Atkinson's Photographic Albums on Plant Breeding and Genetics.

Before joining the Air Force recently, Mr. W. T. Atkinson, Plant Breeder of the New South Wales Department of Agriculture, assembled into albums a large collection of photographs on plant breeding and agronomic topics. These albums are now available, singly or collectively, for loan to agricultural institutions and workers in Australia on application to the Department of Agriculture, Box 36A, G.P.O., Sydney.

The photographs were collected over a period of some ten years, during which the author travelled extensively in eastern Australia and, as Walter and Eliza Hall Fellow, in the U.S.A. and Europe. The arrangement of the photographs clearly labelled and bearing commentaries, into albums on related topics, has provided a novel and effective record for the use of workers interested in special phases of agronomy. Besides the introductory and general albums, there are albums treating lucerne, maize breeding, miscellaneous crop plants, forage plant improvement, forage plant materials and plot methods, caging methods and bagging technique, North-West Plant Breeding work, plant breeding facilities, tools and machinery, ecological and physiological interests.

Obituary

MAURICE S. BENJAMIN

It is with regret that we record the death of Mr. M. S. Benjamin, D.I.C. (London), A.A.C.I., Senior Chemist, Department of Agriculture, New South Wales. The late Mr. Benjamin was a man with wide scientific interests, but his main activities were devoted to the application of the science of chemistry to the betterment of agriculture and allied industries.

His early training was obtained at the Sydney Technical College and in the laboratory of a well known city chemical firm. In 1912 he visited London, where he studied for about eighteen months under the direction of Professor H. E. Armstrong, F.R.S., at the Imperial College of Science and Technology, obtaining the Diploma in Industrial Chemistry of that College in 1913. During the same period he attended lectures at the Sir John Cass Institute and spent some time studying work in progress at Rothamsted Experimental Station at Harpenden.

Soon after his return to New South Wales, he was appointed Lecturer in Chemistry and Soil Physics at Hawkesbury Agricultural College. In June, 1916, he enlisted in the A.I.F. for service overseas, but was released by the military authorities at the request of the State Government. In 1921 he visited the United States, where he spent about twelve months. About half of this period was spent in the study of soils and plant nutrition under the direction of Hoagland and Lipman, whilst the remainder was devoted to visiting the more important centres of chemical and agricultural research, investigating the latest aspects of the work in progress at these centres.

At the conclusion of his American tour he returned to the staff of the Hawkesbury Agricultural College and some years later was appointed to the position of First Analyst, and finally to that of Senior Chemist in the Chemist Branch, Department of Agriculture, which position he occupied at the time of his death.

His genial disposition, his gentlemanly manner, and his keen desire to help, professionally and otherwise, all who might be in difficulty, gained him a multitude of friends and made his passing a source of deep regret to all who knew him.

Our sincerest sympathy is extended to his wife and daughter.

Personal Notes

Mr. E. H. Gurney, Chief Agricultural Chemist, Queensland Department of Agriculture and Stock, has retired under the age-limit regulations. Mr. Gurney joined the staff of the Queensland Agricultural College as Science Master in 1901, and in 1908 was appointed senior analyst in the Department. In 1931 he succeeded Mr. J. C. Brunnich as Chief Chemist.

Mr. W. J. Cartmill has been transferred to Brisbane after being for seven years at the Bureau of Tropical Agriculture, South Johnstone, Queensland.

Mr. F. N. Ratcliffe, of the A.C.T. Branch, has been appointed for entomological work, with the rank of Captain, to the A.M.F.

The following members of the South Australian Branch have recently been called up for active service with the fighting forces : R. J. Beck, B. E. Butler, E. J. Breakwell, W. H. McFarlane, N. S. Tiver, A. J. K. Walker, K. Woodroffe and A. E. Johnson.

Mr. C. K. Vears, formerly Plant Breeder, Wagga Experiment Farm, was recently appointed to the position of Manager, Temora Experiment Farm, New South Wales.

Recent enlistments with the fighting forces from the New South Wales Branch include Messrs. W. T. Atkinson (Air Force), F. Henderson (Meteorological Service of the Air Force), J. Carroll (Radio Location Section of the A.I.F.) and J. Wright (Air Force Reservist).

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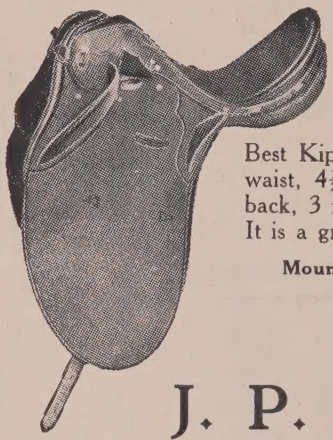

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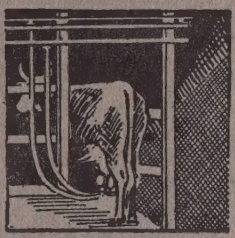

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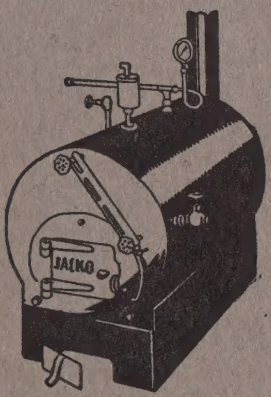

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